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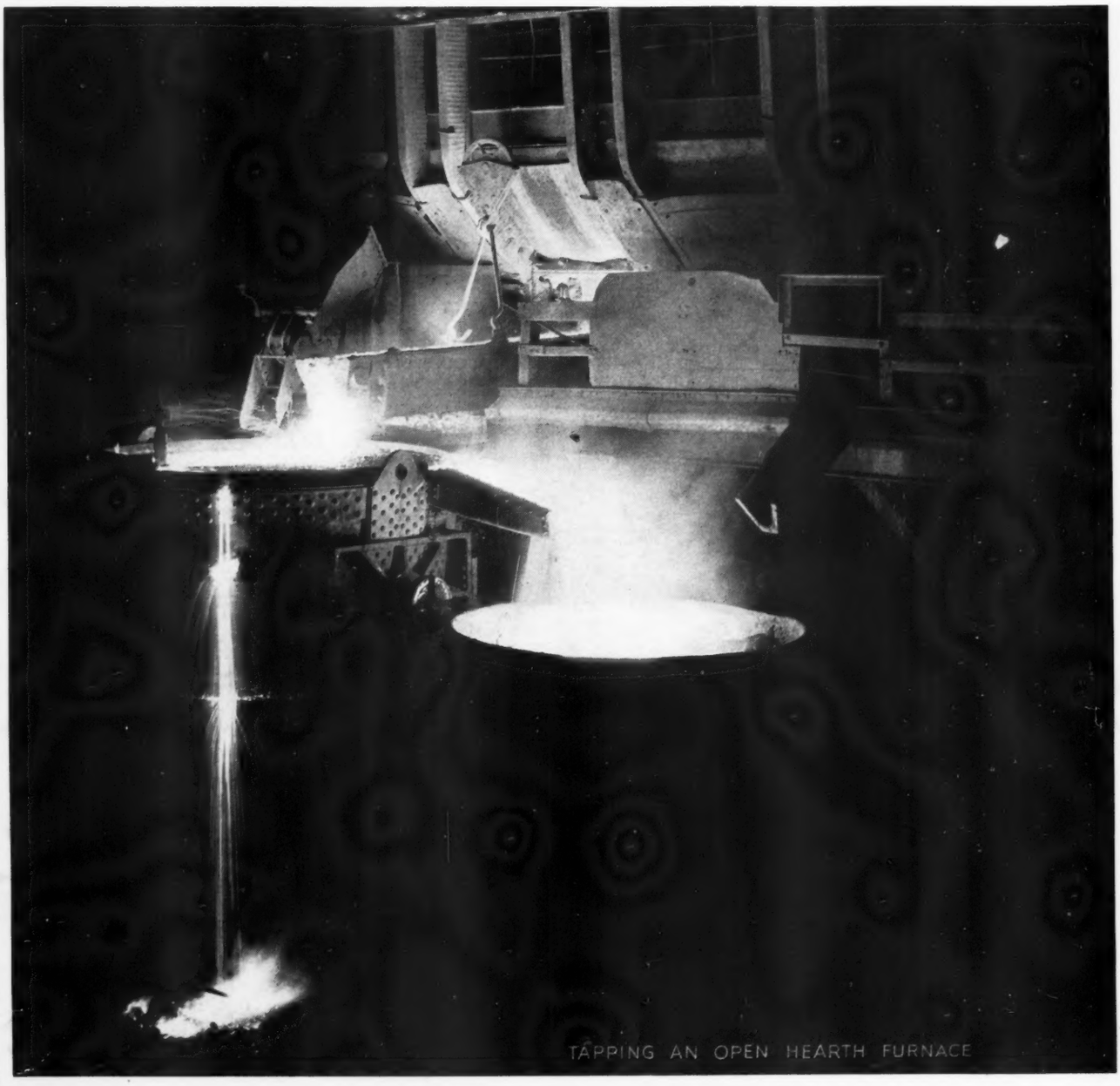

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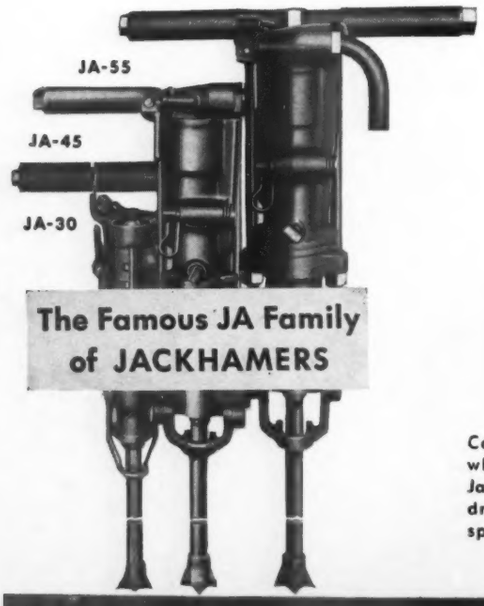
Two-Stage Air-Cooled PORTABLE COMPRESSORS

This Model 85A two-wheel trailer-mounted Portable Compressor is one of the new machines. It operates one JA-55 Jackhamer or two of the largest paving breakers.



The Famous JA Family of JACKHAMERS

Contractors everywhere are adopting Jackbits. They reduce drilling costs and speed up the work.

TO the modern line of Two-Stage Air-Cooled Portable Compressors we have added several new units—Models 55, 85A and 105A Two-Wheel Trailers. They were on display for the first time at the Cleveland Road Show in January.

These newly-styled mountings are extremely rigid and will stand up under severe service. Balance of weight, leaf-type spring mounting and Timken roller-bearing wheels facilitate towing at speeds up to 35 m.p.h.

Two of the new machines, Models 55 and 85A, are new sizes that "team up" perfectly with the modern line of I-R "Jackhamers", Paving Breakers and Pneumatic Tools.

Phone or write the nearest branch office or distributor for your copy of Bulletin 3264 covering these new portable compressors.

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY

ON THE COVER

OUR cover picture shows the last of a 160-ton heat of steel being drawn from a furnace in the No. 5 Open Hearth Shop of the Carnegie-Illinois Steel Corporation at Gary, Ind. Surplus slag is flowing from the steel ladle at the left into the slag ladle, and a small stream of it is also dribbling over the top and falling on to the floor at the lower left. The picture is published by courtesy of the Carnegie-Illinois Steel Corporation.

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IN THIS ISSUE

AMERICA has known many forms of athletics, but probably none that called for greater stamina than the rock-drilling contests which are described in our leading article. The Old West produced many sterling hammermen, and in our times some of them could have made fortunes in other branches of sport. The mechanical rock drill has been a boon to the mining industry; but against it we are compelled to place the charge that it has deprived the camps of their most colorful and interesting entertainment feature. Only fragmentary records of these contests have been preserved, and we have perhaps overlooked some of the giants of old. If any of our readers can add to our account, we should be glad to hear from them.

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SECTIONS of Florida are so little above sea level that ground water lies close to the surface. During rainy seasons the soil soon absorbs all the moisture it can hold, and the surplus accumulates as lakes or swamps. The largest of these swamps is the Everglades. Its water comes largely from the overflow of Lake Okeechobee. By raising the shores of the lake and digging canals to carry the flood waters to the sea, engineers are transforming this vast, worthless swampland into one of the richest agricultural areas in the nation. This little-known undertaking is described by Robert G. Skerrett.

•

OF THE many rip-roaring mining camps that the Old West produced, probably none had a more tempestuous history than the Comstock Lode. It saw speculation that would make Wall Street of today seem tame by comparison. In fact, the idea of issuing shares of stock is said to have been born on the Comstock where the claims were divided into feet and certificates of ownership issued on that basis. Adolph Sutro surmounted great obstacles in driving a tunnel to drain the mines, and one of the Burleigh drills he used recently came under the scrutiny of two students of the Mackay School of Mines. That was the basis for the article that begins on page 5512.

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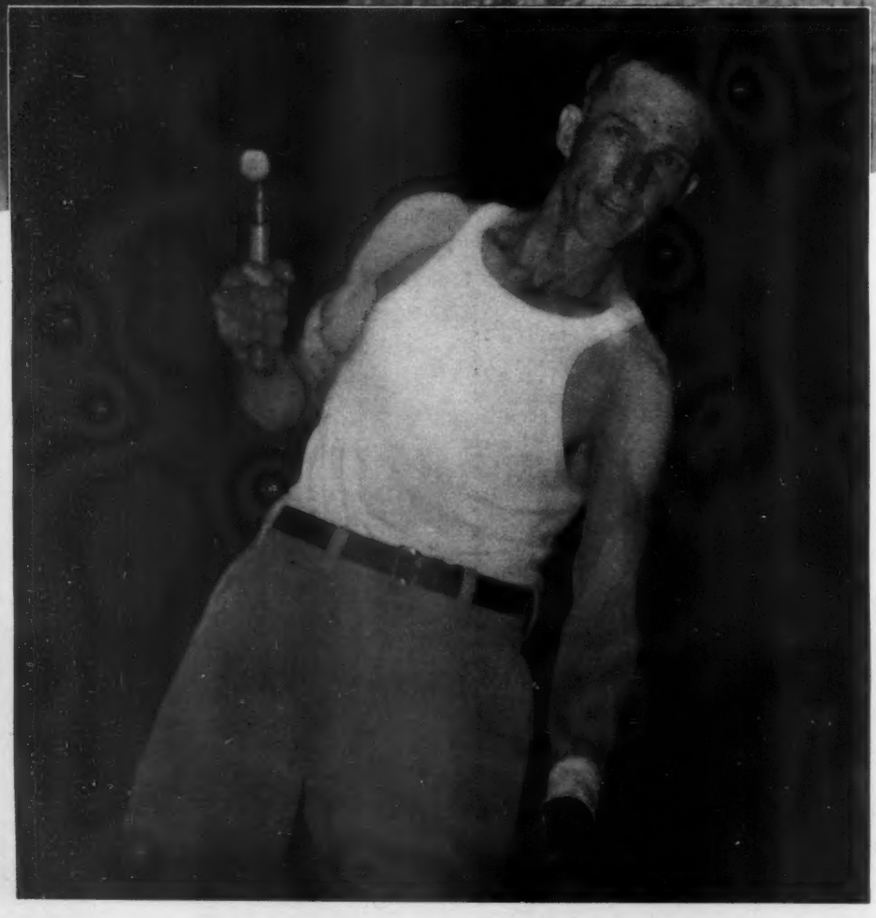
Super Hammermen

Allen S. Park



FUTURE CHAMPIONS

The oldtime champions started pounding a drill early in life, and the boys above are doing likewise. Holding the drill is Clyde Coughlin, aged nine, and swinging the hammer is his brother Bill, aged six. With them, and acting as their "swamper," is their father, Mickey Coughlin, a member of the world's ruling double-hand team. The boys' grandfather also was a leading driller for twenty years. This picture was taken during an exhibition given at Denver in September, 1936, before delegates to the American Mining Congress. It has real drama in it, for it was taken the instant young Bill was demonstrating that he possesses the courage of a true champion. A steel that Clyde pulled from the hole struck his younger brother in the mouth, and his upper lip is seen to be bruised and bleeding. Tears came to his eyes; but the lad, with his father's hand steadying him, kept on swinging. The boys sunk a hole 4½ inches deep in the granite in seven minutes.

At the left is Fred Dopp of Jamestown, Colo., who, at 54 years of age, can still out-drill any man with a 4-pound hammer. Dopp started drilling when he was twenty. He has been beaten only once in 25 contests. In addition, he has competed in 23 double-hand matches, winning twenty of them and standing second in the other three. He has been paired with fourteen different partners. In winning the single-hand matches at San Francisco last May, Dopp drilled 21 inches in fifteen minutes.

BEARING DOWN

The facial expressions of these men give evidence of the physical and nervous strain under which they are drilling. They are Arch Walker and Edward Saunders of Boulder, Colo., in a match staged in front of the Colorado Capitol at Denver during the 1936 meeting of the American Mining Congress. This team stood second on that occasion, and Walker was third in the single-hand drilling. The pair won first place at the Opening of the Bridges Celebration in San Francisco last May, but has been beaten since then by George and Mickey Coughlin, fellow Coloradoans.

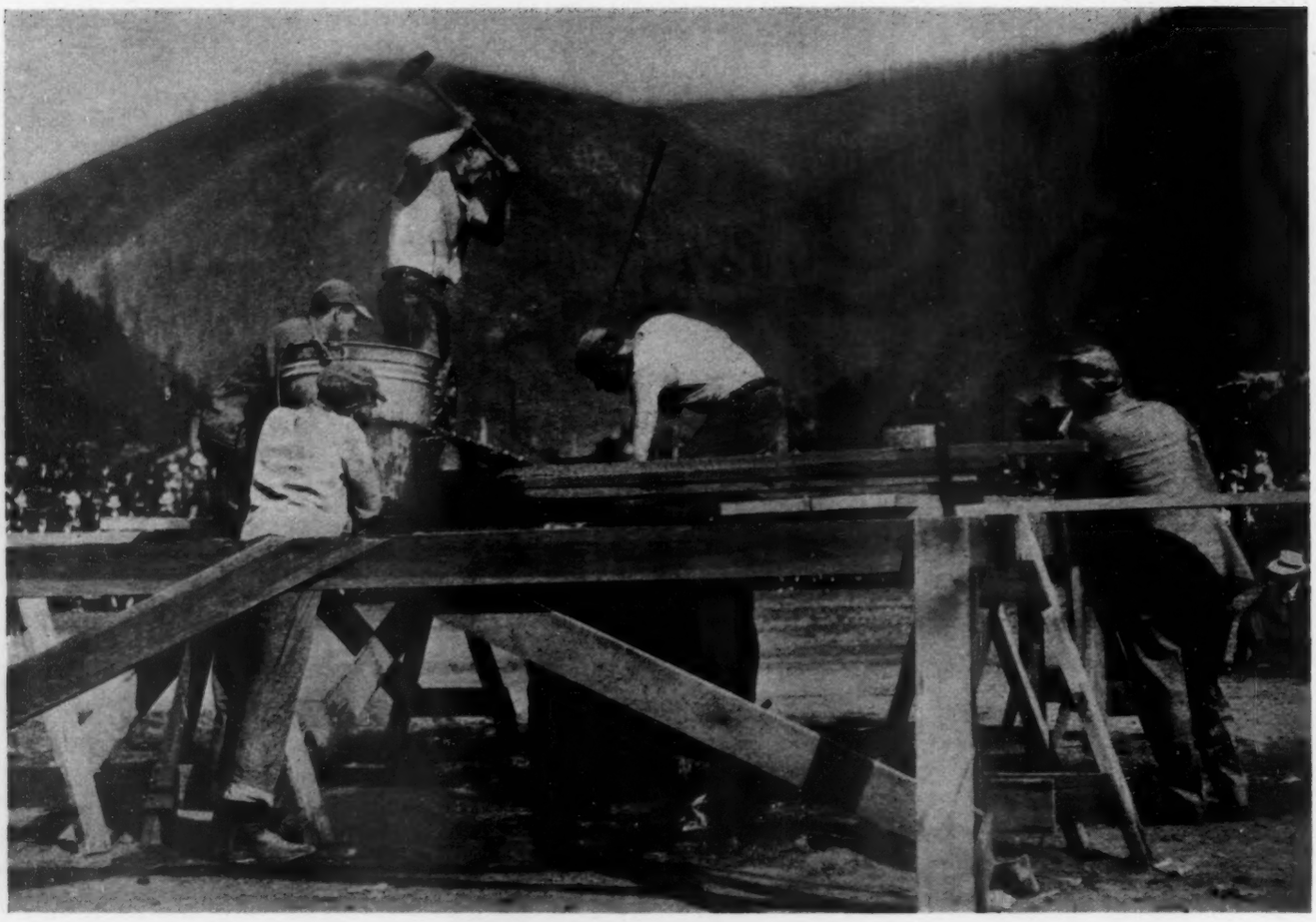
BEFORE mechanical rock drills were generally adopted, most blast holes in mines were drilled by hand. The practice gained in swinging a hammer day after day developed many expert drillers. The best of these matched their brawn and skill in contests that were held regularly in various western mining camps on the Fourth of July, Labor Day, and other holidays. Foot races, baseball games, boxing matches, and other sports had places on these programs, but the drilling competitions commanded the greatest interest. Every miner aspired to become good enough to enter them. The prizes were large for those days, and, in addition to the money, first place carried with it a tremendous amount of prestige.

Those holiday celebrations were gala occasions in the lives of the miners. Many of them got into town infrequently and, after long periods of bunkhouse monotony, welcomed the opportunity to "cut loose." The Fourth of July celebration was ordinarily a 3-day affair. Local merchants and mining companies donated money for prizes. Everybody went to town, both in the literal and the present-day slang meaning of the phrase. Saloons did a land-office business, and after a bit of jousting with John Barleycorn, the crowds argued long and loudly over the prowess of the various drillers. Wagers were freely proffered and as freely taken, and by the time the contestants "went on the rock," nearly everyone present had something at stake on the result. When it was all over, many miners found that they had worked weeks or months for nothing, while others experienced the exultation of sudden affluence. But, obedient to the unwritten laws that ruled the camps, the winners passed their gains across the numerous bars with lavish liberality and, in the end, nearly everybody wound up pretty well broke. It all came under the heading of fun, and when it was over they all went back to their bunkhouses to work and save for the next jamboree.

The larger and more important the camp, the greater were the prizes posted for the drilling contests. Local champions from every section of the western mining area entered them. At least one of them was always advertised as the "championship-of-the-world" competition, and sometimes several of them were characterized in that manner.

Although much fewer in number, drilling matches are still held in certain parts of the West where there is a desire to keep alive the old traditions. And there are still some worthy hammermen, as will be brought out later. Right now we are concerned chiefly with the oldtimers who set marks that the best of the modern performers aim at in vain.

There are two principal classes of drilling: double-hand and single-hand. These terms are more or less self-defining. A double-hand hammer or "double-jack" is gripped and swung with two hands. This type of drilling calls for two men, one to strike the drill steel and the other to hold it in the hole and to turn it after each blow. In single-hand drilling, one man both strikes and holds the steel. Double-hand drilling



A CRITICAL INSTANT

Every second counts in a drilling contest, and an experienced team can change steels without missing a stroke of the hammer. This remarkable photograph, taken during a competition in the Coeur d'Alene District of Idaho a number of years ago, shows the maneuver being performed. Mike Kinsella, who is on his knees, has just thrown a used steel from the hole and it can be seen descending right above his head. While it is still in the air, he has thrust a sharp and longer steel into the hole, and the hammerman, Charles Leis, is about to strike it. Changing steel is a man's job.

is the more spectacular of the two, and therefore more exciting to watch. The two members of a team alternate at striking and holding for a period of fifteen minutes, making the change every minute or less. This calls for a high degree of coöperation, as much time can be gained or lost according to the smoothness with which the change is made. The topnotchers of the old drilling days could perform this difficult maneuver so expertly that their actions had to be seen to be believed.

Unfortunately, records of the various contests were not systematically kept in bygone years, and for that reason it is difficult to ascertain the best marks that were ever made. An effort has been made to obtain information from authentic sources for this article and to check its accuracy insofar as it is possible to do so. It will be appreciated, however, that, because of variations in the hardness of the rock used and in other governing conditions, performance figures do not always tell the whole story as to the relative abilities of the drillers. It is comparatively easy, though, to compile a list of names of topnotchers. The standings of those men are substantiated not only by the marks they set but also by the esteem in which they were held by their opponents, many of whom are still living.

As will be further explained a little later, the preparation of the drill steel was of the utmost importance to the hammermen. Even the best of them could not make good records unless their steel was just right. The forming of bits to precise gauges, and their heat-treating to the exact degree of hardness required, called for the highest type of craftsmanship. Some of the leading drillers made up their own steel, but more often they affiliated themselves with an expert mine blacksmith.

One of the best among these was Walter E. Carr, now an employee of Ingersoll-Rand Company and a resident of Spokane, Wash. It was through his work with some of the crack hand drillers that Mr. Carr developed the type of bit now known as the Carr bit. It is a chisel-like bit with one cutting edge, as contrasted with the 4- or 6-edge bits that came into vogue with mechanical drills, and is still considered the best type for certain drilling requirements. From records in his possession, from his memory, and from conversations with former premier drillers who are still alive, Mr. Carr has compiled for this article a fund of information from which we now quote:

"There were men in almost every mining camp who were outstanding hammermen—either single-jack or double-jack. Some came from the larger centers and others from isolated camps. Oftentimes they became disciples of great drillers when starting out as miners, and resolved to develop themselves into worthy competitors. Many of them began practicing when only young boys. Of course, very few reached the pinnacle, for the greatest became veritable giants in their line.

"The really great drillers trained for the contests in the same manner that any great athlete trains. They were careful of their diet, and most of them neither drank nor smoked. Those that did were temperate in these habits, for otherwise they could not hope to withstand the terrific strain of a drilling competition. Good double-hand hammermen would practice for months

PICKENS AND BRADSHAW

Jim Pickens, striking, and Walter Bradshaw at Douglas, Ariz., on July 4, 1906. With 10,000 persons watching, they tied for first place with Bill Ross and Jack McIver. To settle the issue, the two teams met again at Lowell, Ariz., on July 23. Pickens and Bradshaw won and split $2,600 prize money. A drill steel thrown from the hole by Bradshaw is seen near Pickens's left hand. The man in the white shirt is Bill O'Neill, the "swamper," whose duty it was to control the flow of water to the drill hole. Bradshaw, now 64 years old, is a hoisting engineer at the Steward Mine in Montana.

before a contest. They knew every trick of the game and, in addition, were powerful men with no end of wind and stamina to carry them through.

"As is true of other lines of athletic endeavor, there is a great deal of science attached to this drilling game. One of the all-important items is steel. The bits must be extremely hard and tough and be gauged to a thousandth of an inch. The steel used is ⅞ inch for double-hand work and ¾ inch for single-hand. It is of octagon section, but the lower portion is rounded, leaving only enough of the octagon to make holding and turning easier. There are fifteen pieces of steel in each 15-minute set, and this means that the steel is changed every minute.

"Expert double-hand drillers allowed 3 inches difference in length between succeeding steels. This meant that if they drove each piece of steel 3 inches in one minute, they would have a hole 45 inches deep when they were through. An extremely small variation in the size of bits was necessary to get the most drilling done in the allotted time. The bits were works of art, and they were polished and gauged so that there was practically no difference in their measurements. Binding in the hole would spell defeat, and yet the bits were made so close to the actual size of the steel that it was necessary to caliper them from every angle to make certain that they would work freely and not stick. The bit of the last steel in the set was exactly the size of the bar. Of course, the men struck very heavy blows, and even the small bits cut into the hard rock with enough margin to permit the cuttings to fly out of the hole at each stroke. A small stream of water was directed into the hole by a man who was called the 'swamper,' the amount being closely controlled so that there would be just enough to mix well with the cuttings.

"Old steel was generally used for practicing, a new set being made up and tempered perfectly for the contest. Wherever possible, it was done in secret so that no one should learn in advance of a match what the team was capable of doing. Usually a piece of steel was dropped in the hole when practice drilling was concluded so that anyone waiting to measure it would learn nothing.

"The contests were held throughout the West, and were particularly popular in Arizona, where many of the best records were made. Cripple Creek and Leadville, in Colorado, and Butte, Mont., were other camps in which these superdrillers met. The mining companies fostered and encouraged the matches, as they aroused great interest among the miners in their work and raised the drilling standards in the mines.

"The rock used for the record contests came from Gunnison, Colo., and was known as Gunnison granite. No marks were recognized as official unless they were made in this rock. Large blocks of it were shipped to various parts of the West for the competitions. The surface of each block was marked off into 4-inch squares, and each square was numbered. Corresponding numbers were placed in a box, and all teams or single-hand contestants drew from these to determine their drilling locations.

"The standard weight of a double-jack

A 1901 CONTEST

Angus McLeod striking and "Sell" Tarr "twisting" a drill during a match held at Idaho Springs, Colo. They won the contest easily. It will be noted that McLeod was a left-hand swinger. It is evident from this picture that women, as well as men, found drilling matches interesting.

is 8 pounds. I know of no instance where the hammers were actually weighed, for the reason that the weight was stamped on each by the manufacturer. However, they were not always accurately marked. All official single-hand records were made with hammers of 4 pounds maximum weight; but in smaller local contests hammers weighing up to 5 pounds were sometimes allowed. There were no restrictions as to the length of the handle. Double-jack handles usually measured 30 inches from the eye of the hammer to the end: single-jack handles varied greatly and in accordance with the driller's style. A fast striker used a short handle, and a slow striker a long one. Thus they ranged all the way from 12 to 20 inches in length.

"The splash method of cleaning the hole with water was introduced at Denver, Colo., about 1892 by a team of Butte drillers, Page and Reagan. The records disclose that they also were the first to change steel without missing a blow and that they originated the maneuver known as 'fostering.' This is the striking of two blows by each of the men as they change positions without touching the steel by hand. One man is on his knees turning the steel and the other is hammering, and they alternate every minute or half-minute, as they choose. At the instant of change each has a hammer in his hands and both strike two blows while they are shifting. Under the strict rules that govern the contests, the man who is changing from hammering to turning is not permitted to strike more than two blows, otherwise the team will be penalized.

"Changing steel every minute is a man's job. To throw a long piece of steel from the hole and to place the next and longer one in it while the hammerman is raising his hammer requires strength, skill, coolness, and extremely fast action, especially when the striker is swinging at the rate of as many as 85 or 90 blows per minute. Yet the hammerman does not break his rhythm; and if one were not looking, it would be impossible by timing the blows to tell when the change was made. The used steel flashes into the air, and the one replacing it is smacked to the bottom of the hole a split second before the hammer descends on it. It is, indeed, a thrilling sight to see two expert drillers perform this feat.

"Many champion drillers were developed in Colorado mining camps; but none of them remained at the top in team drilling longer or more persistently than did Ed Chamberlain, a powerfully built man of about 210 pounds and very clever. When Chamberlain first came into the limelight he had a partner named Andraig. They were from Cripple Creek. Then there were Treweek and McKenzie of Leadville, and the 'Terrible Swedes,' Lindquist and Lumberg, from Ouray. A little later came the Tarr Brothers, Henry and W. G. ("Sell") from Idaho Springs. They won the double-

hand contest at El Paso, Tex., in 1903 with a hole around 44 inches deep. In addition to a large purse, each received a gold medal suitably engraved. W. G. Tarr is now a successful copper-mine operator in Arizona.

"Two fine drillers produced in the Coeur d'Alene District of Idaho were McLean and Mike Kinsella. The latter lives in Wallace, Idaho, and could without doubt drill a good hole today with a little practice. This team went to Hancock, Mich., in 1911 and put on an unusual exhibition. With a man named McCormack turning for them, and both of them striking, they drilled 59½ inches in Vermont granite in fifteen minutes. Kinsella weighed 210 pounds and McLean around 185. Drilling with Mike McNichols at Butte in 1912, Kinsella made a very creditable showing. McNichols weighed at least 225 pounds; and during the final minutes of a contest he would strike very fast by whipping the hammer up and down by arm power alone. He

teamed with Bill Ross in contests around the Northwest, and they were always hard to beat. William Page and Jim Pickens were other Coeur d'Alene drillers of prominence. They won several contests in the Butte District in 1912.

"The Tarr Brothers and Chamberlain went to Bisbee, Ariz., in 1903. There Chamberlain took as his partner Ed Malley, who was not so large as drillers go but who made up in strength, skill, and determination what he lacked in size. Then Chamberlain paired with Carl Maka, who had made a name for himself in Leadville with a man named Stewart. When Stewart dropped out of the picture, Maka teamed with Jack McIver who, in after years, made a fortune in the United Eastern Mine at Oatman, Ariz. This was a strong combination. Next Maka cast his lot with Chamberlain, and this pair drilled the deepest hole ever put down in Gunnison granite by two men. Their record of 46⅝ inches was made at Bisbee in 1903. Competing against them that day were most of the country's crack drillers—Bill Ross, Ed Malley, Pickens, Walter Bradshaw, the Tarr Brothers, the Page Brothers, Bob Lyons, McKenzie, and Jack McIver. All were good men, but no two of them could beat the hole that Chamberlain and Maka drilled that day.

"Straightway drilling is another variety of double-hand drilling in which very few men ever became great. In events of this kind, one man swings the hammer for fifteen minutes without a break, selecting a man to his liking to do the turning, or 'twisting' as miners term it. 'Sell' Tarr, although not so powerful in appearance as some other great performers, was the king of straightway drillers. He was 6 feet 1 inch tall and weighed around 185 pounds. He handled the hammer with much grace, and was never beaten in a straightway match. Such contests usually were the outgrowth of arguments between the friends of great drillers. Miners would back their favorite with everything they had, and large sums of money often changed hands at these unofficial competitions.

"The last great match of this kind in which Tarr took part was in 1903 against Bill Ross. It was hard to gauge Tarr's real ability, for he seldom had to exert himself to win. At one time a large sum of money was posted by his friends in Cripple Creek to back their contention that no 2-man team in the world could give him a handicap of 4 inches and beat him in fifteen minutes. The challenge was never accepted, and probably with good judgment. It was well known among Tarr's close associates that he could drill 42 inches in Gunnison granite anytime he cared to make the effort. To beat him under the conditions laid down, a team would have had to drill 46 inches, and that was never done but once in Gunnison granite.

"The Tarr-Ross match was held at Bisbee in the fall of 1903. There was a side bet of $700 between backers of the two. Ross was a big man, skillful with a hammer, and with plenty of power and wind. He was the first to drill. Carl Maka, whom he had selected to twist and change steel for him, did a perfect job of it. Ross started off beautifully. He swung into action at the rate of 70 blows a minute and kept it up to the end. When he had finished, his hole measured 35¼ inches deep and his friends thought their money was safe.

"Tarr had chosen Ed Malley to handle the steel for him, and when these two appeared on the rock they received an ovation from the crowd, as both were very popular. As previously mentioned, Tarr's looks in street clothes were deceiving. Compared with Ross, he looked slender; but when he stripped for action, it was evident that he had a powerful torso and arms. His body was lithe, with long, smooth muscles, and his huge chest gave him tremendous breathing capacity. When starting time was called, Tarr began delivering 70 blows a minute, which gave Malley an opportunity to start a good hole. Once warmed up, however, he speeded up to 85 blows a minute and, with grace of movement, maintained that clip for the full fifteen minutes. The tape showed his hole to be 38⅝ inches deep.

"The hammers used were branded 8 pounds; but if anyone had actually removed the handle from Tarr's and placed it on the scales he would have found that it really

THE DRILLER

This statue, made of concrete sheathed with lead and then with copper, was erected at Bisbee, Ariz., in November, 1935, and dedicated to "those virile men, the copper miners, whose contribution to the development of the wealth and lore of the State of Arizona has been magnificent." The sculptor was R. Phillip Sanderson. The figure bears a single-jack hammer in the right hand and a drill steel in the left. The granite block which forms the base of the statue is the one that was used for the world-championship drilling matches at El Paso, Tex., in 1903. The close view below shows the drill holes in the top of it. The picture on the following page depicts the Tarr Brothers winning the double-hand contest at El Paso.

FAMOUS BROTHER-TEAM

Henry and W. G. ("Sell") Tarr, winning the championship double-hand contest at El Paso, Tex., in 1903. "Sell" Tarr has just thrown a short steel from the hole, and it can be seen falling at the right-hand corner of the platform. W. G. Tarr now lives in Mammoth, Ariz. Shown between the drillers and handling the water for them is Dick Connely, a former well-known single-hand champion.

weighed 9 pounds 3 ounces. Tarr apparently never tired, and after a rest of five minutes probably could have drilled another hole as deep as the first one. His stamina was remarkable, when it is considered that few men could continue this violent exertion for fifteen minutes without stopping at least once to rest.

"Although single-hand drilling is not so thrilling to watch as team drilling, it calls for great skill and endurance, and there was much interest in it. The notable contests staged at Bisbee in 1903 included competitions of this kind, and many of the best individual hammermen of the country were either working or visiting in the district at the time. Among them were Dick Connely, who was the reigning single-hand champion, Bob Lyons, McGowan, Liggen, O. M. King, Malcolm, and others. One who was not considered a contender for first place was also there. He was Fred Yockey, who had grown up around Nederland, Colo., where he had done some excellent work. However, he was totally unknown in the Southwest.

"Yockey had begun drilling when he was a young boy, using the granite bowlders that abound in the Nederland District to practice on. In July of 1901 or 1902 he entered a contest at Boulder, Colo., which was an annual event of the Chautauqua season that is still conducted there. The rock used was known as Corapaxie granite, light in color and soft as granites go. When Yockey climbed up on the rock, his set of steel was noticed to be very long for a single-hand driller. The crowd thought he was a greenhorn and began to taunt him. 'You'd better get something to stand on, son, or you won't be able to reach the long ones after awhile,' someone shouted. There were other similar gibes, and the crowd laughed heartily, but Yockey responded only with a smile. When he began drilling, it was seen that he struck very fast, and the wiseacres in the group of spectators were sure that he could not maintain that pace. But as the minutes ticked by he didn't tire, and at the finish he was hammering away at the same rate and twisting the long steel with two fingers of his left hand. He won first money with plenty of time to spare.

"Much the same scene was reënacted at Bisbee in 1903. Yockey was a quiet, unassuming fellow; but he was accompanied by friends who knew what he could do, and they made the rounds of the saloons placing bets that he would win the single-hand contest. When Yockey started drilling, the crowd fairly gasped when they observed the speed with which he struck and the dexterity with which he turned the steel. It was remarked that 'if he holds out, there will be a new champion'; but few thought that any man could keep up the pace he had set for himself. But he did, averaging 144 strokes a minute for the 15-minute period. His hole measured 26⅝ inches; and it has never been surpassed in Gunnison granite with a 4-pound single-jack. Yockey received $400 in prize money. In addition, he and his friends won a large sum in side bets.

"Yockey studied his movements until he was able to turn the steel and deliver his blows in rhythm. His timing was perfect in any kind of rock. He also produced his own bits, and by patient experimenting learned to make them so that they were just right for his particular stroke. He held first rank among all comers for years. He was a human machine that it took years to develop. Few boys would be persistent enough to practice and to train from childhood as Yockey did."

In connection with Mr. Carr's account of the match at Bisbee in 1903, in which Chamberlain and Maka set the record mark in Gunnison granite, it was mentioned that Walter Bradshaw was among the contestants. Mr. Bradshaw, at 64, is a resident of Butte, and was the subject of an article in the *Butte Daily Post* a few months ago. He was among the leading drillers for many years; and at Spokane, Wash., on Oct. 25, 1901, he and Jo Freethy drilled 55

inches in fifteen minutes. However, the rock was not Gunnison granite.

Bradshaw started drilling in Colorado when he was fifteen years old, and went to the Butte District in 1891. He took part in contests in various parts of the West, and his prize money totaled $13,000. He and Jim Pickens divided $2,600 at Lowell, Ariz., on July 23, 1906, when they defeated Bill Ross and Jack McIver. The two teams had tied at Douglas, Ariz., on July 4, and the second match was arranged to decide the supremacy. The original purse was $1,600, but mine owners increased it by $1,000 as an incentive to the teams at the Lowell meeting. Bradshaw and McNichols won $2,250 on August 13, 1906, by taking first place in a contest held at Columbia Gardens in Butte. On that occasion their hole was 45 1/16 inches deep. Bradshaw and others went to New York in 1908 to take part in a drilling competition that was scheduled at Madison Square Garden; but at the last minute the promoter canceled the event.

Bradshaw's life bears out all that has been written about the rigorous training and careful habits observed by these drillers. He neither smokes nor drinks, and ascribes his abstention to his drilling career. "We used to train for each contest for about six weeks," he states. "This had to be done in the evening, after we had finished our shift in the mine. First we would practice changing steels and striking. Then came a run of several miles in the hills to improve our wind. Finally, we would do some limbering-up exercises and then go to bed." In his drilling days, Bradshaw weighed 205 pounds. He attributes some of his success to the fact that he changed the shape of his hammer, flaring it out on the face so as to place more weight just behind the striking surface. Some commercial hammers are built on that principle now.

In addition to the advertised contests in which many teams were entered, numerous impromptu matches were held in the mining camps between individual drillers or teams. These usually were arranged to settle arguments between the backers of the respective contestants, and they generally were enlivened by a sizable side bet. An account of one of these matches was recently published in a Butte newspaper in the form of a reprint of the item as it appeared in May, 1888. This was a straightway drilling contest between Henry Page and Pat Kelly, and was the outgrowth of a previous match in which Kelly had defeated Page's brother William. The description of that contest follows:

"The match was for $250 a side and was held back of the Parrot mine before a crowd of 500 miners. The Anaconda mine force offered 5 to 3 on Page with few takers. Page weighed 156 and Kelly 160. Tom O'Neil turned for Page and Pat Hanley for Kelly. Jack Quilty acted as referee. William Scallon was timekeeper for Page and Dan Sullivan for Kelly. When time was called, Pat Kelly drilled very industriously for 15 minutes. Measurement showed that he had drilled 14½ inches in a granite formation dry hole. Page then beat his adversary by 3½ inches, drilling 18 inches in 15 minutes. After a 30-minute rest, Kelly started to drill in a hole in which water was used. He drilled 6 inches in 7 minutes. Page drilled 7 inches in 4 minutes. He was declared the winner."

Among the more modern generation of drillers, Fred Dopp of Jamestown, Colo., is easily the leader. At the age of 54, and after 34 years of competition, he is still conceded to be the best man with a single-jack in the country. In addition, he has been a member of the premier doubles team throughout most of those years.

Dopp started drilling at Jamestown in 1904 and, with Cliff Collins as his partner, won the first double-hand contest he entered. He was twenty years old at the time. The next year they lost, but in 1906 Dopp and Charles Dahlin regained the top rank. All told, Dopp has drilled in 23 contests with fourteen different partners, has won first place twenty times, and second place three times. Four years ago he and his partner were beaten, and he resolved to retire from double-hand competition; but last fall he reconsidered and took part in two matches. Teamed with Arch Walker, he won second place at Virginia City, Nev., and first place at Yreka, Calif. Dopp states, however, that George and Mickey Coughlin of Sugar Loaf, Colo., are now considered to be the best doubles team in the country. They gained that distinction by beating Arch Walker and Edward Saunders, of Boulder, Colo., who had previously won first place against all comers in a contest held at San Francisco last May in connection with the ceremonies marking the opening of the two new bridges.

Dopp's record in single-hand drilling is truly remarkable. In 25 contests he has been defeated but once. That was at Central City, Colo., last summer, when Arch Walker bettered his hole by one-sixteenth of an inch. Since then, however, he has beaten Walker on three separate occasions.

Any effort to compare the records of Dopp and his contemporaries with those of the oldtime drillers is unsatisfactory for the reason that for many years there has been no uniformity in the rock used. Whenever a match is arranged nowadays, the granite is usually obtained from the nearest source of supply. In Colorado, where Dopp has done most of his drilling, granite from Silver Plume was nearly always used until a few years ago. It was believed to be the hardest granite procurable; but no definite basis upon which to compare it with Gunnison granite is available. Drilling in this rock at Boulder, Colo., Dopp and Peterson set a mark of 34¼ inches. At Leadville, Dopp and Peterson drilled 40 inches in Platte Canyon granite, which also is considered to be harder by Dopp than the Gunnison rock.

Dopp's best single-hand record is 18½ inches in ten minutes, which has been the duration of most contests of this kind for a number of years. This is at the rate of 27¾ inches for fifteen minutes, but cannot be fairly compared with Yockey's all-time high mark of 26⅝ inches in fifteen minutes of actual drilling time in record rock. It is safe to assume, however, that Dopp, in his prime, would have proved a serious competitor for the best of the oldtimers. At San Francisco, last May, Dopp drilled 21 inches in fifteen minutes, which is certainly a creditable mark for a man 54 years old.

Despite the fact that the mechanical rock drill has made hand drilling almost a forgotten art, it is probable that certain parts of the West will not permit contests of this type to die out. One such community is Boulder, Colo., which has known and liked the sport for 40 years or more. Each summer the mining interests there promote what is termed the Pay Dirt Pow Wow, and drilling matches have a prominent place on the program. They are held at night under floodlights in the University of Colorado stadium, and attract several thousand persons.

With an eye to the future, the committee in charge arranges one match for boys. This makes sure that at least a few youngsters in that particular section will begin training early in life, as the foremost performers did years ago. With such a start, perhaps some of them may yet measure up to the stature of such men as Chamberlain, Maka, "Sell" Tarr, Bradshaw, McIver, Yockey, Dopp, and the other master hammermen of an era that is now waning.

BEST IN "DOUBLES"

George (left) and Mickey Coughlin, of Sugar Loaf, Colo., who are recognized today as the champion double-hand drillers. They are cousins. The Coughlins won the title recently by defeating Arch Walker and Edward Saunders of Boulder, Colo., who stood first in a contest held last May in San Francisco in connection with the Opening of the Bridges Celebration.

Reclaiming the Everglades

Robert G. Skerrett

DIRT-MOVING EQUIPMENT

The operations have involved the employment of a great number of large machines for dredging channels and building levees. The picture just above shows a section of the levee along the southern shore of Lake Okeechobee, with the paralleling navigation channel on the right. In the upper left view is seen a suction dredge clearing the channel of the Caloosahatchee River.

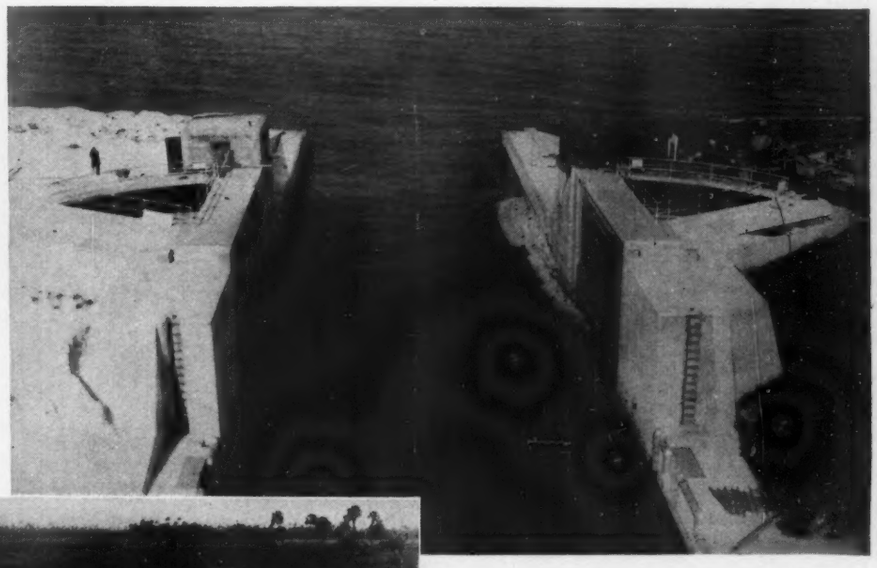
"WHERE summer spends the winter"—so runs the patter of the publicity man—the Government has completed major engineering undertakings that promise physical security to that potentially vast agricultural realm that lies in the southern section of Florida's great peninsula. For generations this far-flung area, known as the Everglades, was deemed little better than a territorial waste in which thrived various aquatic birds, alligators, rattlesnakes, and other reptiles. It was penetrated mostly by Seminole Indians, by some commercial hunters, trappers, a few traders, and an occasional explorer. To most of us, it was believed to be only a low-lying marshy wilderness—thanks to the description commonly found in our school geographies.

No serious attempt was made to drain the lands along the margins of the Everglades prior to 1881; and then the state made a contract with private interests to undertake the work for a compensation of one acre of reclaimed land for every 25 cents expended in that effort. Operations to that end continued intermittently for twelve years, and the drainage companies were awarded 1,652,000 acres. The lands thus obtained lay mostly north of the Everglades where the work of draining them was not especially difficult. Attempts to drain the Everglades proper were started as recently as 1906 by Florida itself through the Board of Commissioners of the Everglades Drainage District. The state built and put in service several dredges which were used to excavate a number of canals extending from Lake Okeechobee southward and eastward through the Everglades to the Atlantic seaboard. These canals were designed to carry seaward flood waters both from the lake and from the lands adjacent to them.

Work within the Everglades Drainage District went steadily forward, even though the nation at large was unaware of the progress made in transforming that erstwhile forbidding region. At the close of 1928 the population in that territory had reached 48,000, the aggregate area under cultivation had expanded from a few acres to 96,000 acres, and the value per acre, based on the average state land sales, had increased from $1.25 to $92.68. At the beginning of the following year the Everglades Drainage District had in service 440 miles of drainage canals which had required the excavating of 75,062,552 cubic yards of

RECLAIMED LAND

Dusting beans on a truck farm in the Everglades. The soil is extremely fertile, and seeds germinate quickly and crops mature in an amazingly short time in the subtropical climate that prevails.



TWO TYPES OF GATES

Above, at the right, is one of the new hurricane gates in open position at the lake end of a drainage canal. The other picture shows a drainage spillway, one of the numerous structures designed to control water flowing from neighboring canals into the Saint Lucie Canal, the object being to minimize erosive action and the discharge of obstructive silt into the navigable channel of the latter.

material at a cost of $14,871,185. Associate control works in the form of locks, dams, and levees raised the total expenditures on the entire project to $17,926,100. Then nature, in a violent mood, stepped in and tipped the apple cart of the prospering district. The hurricanes of 1926 and 1928, which resulted in physical and economic disaster, forced the state to turn to the national Government for aid, which was authorized by Congress in July of 1930. Before describing what has been done since then by the Corps of Engineers of the U. S. Army it would be well to tell what the task has involved.

The drainage of the Everglades rests fundamentally on the control of Lake Okeechobee, which lies at the northern limits of that marshland and south of an immense watershed that delivers most of its run-off to the lake. The Everglades Drainage District embraces an area of 4,370,000 acres, and slopes southward from the lake at the rate of only 2 to 3 inches per mile, in fact, is so nearly level that water reaching that expanse moves but slowly toward the sea. This sluggish relief of rain or flood waters explains why the Everglades have been commonly considered a veritable swamp. They have an average east-and-west width of 40 miles, and extend from Lake Okeechobee southward for 90 miles, merging with tidewater at the lower extremity of the peninsula. For miles and miles, the Everglades have the appearance of an unbroken meadow; but the verdure is mainly saw grass—a sharp-edged growth that rises from the water, is nearly as tough as bamboo, and is difficult, painful, and even impossible to penetrate. Winding and shallow water routes have been the accustomed courses by which Indians, hunters, and explorers have made their ways in and out of the region.

The saw-grass areas are dotted occasionally with "hammocks"—low insular formations that carry spindly trees and a dense undergrowth. The latter sustain vegetation of different kinds, showing the natural fitness of the soil for cultivation. Until recently, the saw-grass lands required several years of working after drainage to condition them for the growing of profitable crops; but the agricultural chemist has discovered how this period of preparation can be shortened amazingly.

The prevailing soil of the Everglades is a deposit of vegetal matter that has accumulated through untold time on the bottom of

DETAIL SKETCH OF STRUCTURAL FEATURES

The solid, heavy lines along the north shore and the entire southern half of Lake Okeechobee indicate the new levee system. The paralleling inner line along the southern levee is the outer boundary of the new navigation channel. Key to lettering: *D D D* —drainage culverts; *H H H*—hurricane gates; *S*—drainage spillways. Lake Okeechobee is now the intermediate link in a cross-state navigable waterway about 150 miles long.

a vast shallow limestone basin that is open to the sea only at its southern end and flanked on the east and west by confining low ridges of the same limestone formation. The soil, familiarly known as muck, is naturally rich, and varies in thickness from 2 feet at the southernmost limits of the basin to 12 feet and more where the Everglades meet Lake Okeechobee. The program of the Everglades Drainage District calls for the progressive reclamation of 2,300,000 acres of the proved fertile soil.

The soil, combined with an abundance of sunshine, ample rainfall, and a climate that ranges from semitropical to the subtropical—depending upon the location—makes it feasible to grow advantageously many kinds of fruits and vegetables. Germination is extraordinarily rapid, the yield is large, and the crops can be harvested and forwarded to market at seasons when the highest prices can be obtained for them. The most populous sections of the nation are situated where they can be reached by the transportation systems available for the distribution of Florida's produce.

Before any efforts were made to drain the Everglades, the flood waters that reached Lake Okeechobee escaped thence southward over the low section of the surrounding rim and flowed on to the outlying lands of the Everglades—the inundating water subsiding through evaporation or through its protracted movement southward to the sea. Most of us do not know it, but Lake Okeechobee is said to be the second largest body of fresh water wholly within the United States. Its normal surface expanse is 730 square miles, it has an average diameter of 31 miles, but it is generally shallow. The bottom of the lake, where deepest, is at sea level, the normal maximum depth being 15 feet. Shallow as it is, the lake acts as a catch basin for a watershed of nearly 4,200 square miles lying to the north of it. There is a further area of 300 square miles immediately contiguous to and sloping toward the lake from the west, east, and south, making, together with the surface of the lake and the tributary watersheds, a total of approximately 5,200 square miles on which the rains fall during Florida's annual wet season through May to the end of October.

In the course of two months, from year to year, the water reaching Lake Okeechobee has ranged from 47,000,000,000 cubic feet to 64,000,000,000 cubic feet; and for ages that excess poured over the south rim of the lake basin and on to the Everglades. To block that low section, the state built a succession of levees from 8 to 10 feet above the local ground level with muck and marl dredged from near by—placing reliance upon the four main drainage canals to detour flood waters from the Everglades and to lead it to the Atlantic. Later, when those canals were found to be inadequate as safety valves for the lake and as relief channels for the lands neighboring those man-made passages, Florida dug the Saint Lucie Canal—also connecting with the Atlantic—as a major means of lake control. Previously, there had been excavated a canal extending from the southwest corner of Lake Okeechobee to the headwaters of the Caloosahatchee River. The latter outlet was never effective because of the shallowness and the crookedness of the Caloosahatchee.

Such was the situation in 1926 and 1928 when Lake Okeechobee was swept by two hurricanes. The winds blew at velocities well over 100 miles an hour, created walls of water 12 feet and more in height, and hurled them against the levees—overtopping them, eroding them, and breaching them. In 1928 alone the loss in lives was about 2,000, and the property damage was substantially $3,800,000. The inundated lands remained submerged for weeks thereafter.

Since 1930, the Corps of Engineers, U. S. Army, has designed and constructed new defences on the shores of Lake Okeechobee; has erected a succession of hurricane gates at the entrances of all canals tapping Lake Okeechobee where such provision is needed; and the Saint Lucie Canal, the Caloosahatchee Canal, and the Caloosahatchee River have been dredged, equipped with new navigation locks, and in other ways made capable of carrying off a combined total of 7,500 cubic feet of water per second—ample, so it is believed, to keep the lake under control even at maximum flood stage. Its northern shore now has, for the first time, 15 miles of an improved type of levee, while the entire southern half of the shore line is guarded by other levees for 68 miles. The latter are far sturdier and better in every way than the older ones built by the state; and their crests are fully 4½ feet above the highest recorded waves that did so much damage in 1926 and 1928. No muck has been used in the new levees; and in excavating the marl, shell, sand, and rock of which they are formed, the borrow pits became sections of a navigation channel that parallels the southern levees. This channel affords a sheltered course between the Saint Lucie Canal and the Caloosahatchee Canal, and is deep enough for craft not drawing more than 6 feet of water. Thus yachts, fishing boats, and freight barges can use this inland waterway, which links the Atlantic with the Gulf of Mexico, instead of following the outside route which is about 300 miles longer and in the open sea. The new locks on the Saint Lucie and

Caloosahatchee canals are 250 feet long and 50 feet wide, sufficient to handle sizable vessels.

The Lake Okeechobee Project, as the work is officially known, is a well-balanced engineering undertaking, and promises adequately to safeguard not only those areas of the Everglades that have already been drained and put to use but those still greater expanses that are to be reclaimed and placed under cultivation hereafter. The region, agriculturally, is unique in this country because of the abundance of favoring conditions which are brought together there. Nearly all the Everglades enjoy a subtropical climate, and the reclaimed soil is of exceptional richness because it is made up mainly of more or less perfectly decomposed vegetal matter. The soil, however, is deficient to some extent in desirable mineral substances; but when that shortage is made up it is possible to obtain fine crops.

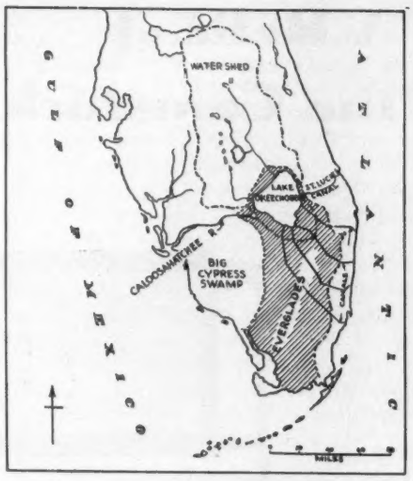
The trend now is to make a virtually year-round use of the soil; and this includes the growing of certain foodstuffs on a very large scale by advanced commercial methods. At the present time, the principal agricultural products include various citrus fruits, corn for grain, sweet potatoes, white potatoes, peanuts, celery, peaches, pears, winter vegetables, sugar cane, and cotton. Incidentally, various subtropical and hitherto exotic fruits are being grown; and their cultivation is undergoing extension so that the output in the near future will be of considerable volume and susceptible of distribution throughout the whole country. Livestock of different kinds thrives on the reclaimed lands. Associated with agriculture, there are industrial developments of importance that indicate in a general way some of the lines upon which upbuilding of the region can be counted upon to go forward steadily.

It is said that sugar cane attains a height of 10 feet in the Everglades. Cotton ripens its bolls there three months sooner than elsewhere in the United States. Palm nuts, which in their accustomed environment take three months to sprout after planting, push their leaves through the soil in the course of two weeks in this favored region. Beans and peanuts are hardly planted before their sprouts appear—this happening in so brief a span as two days; and bananas will bear in half a year. Authoritative reports of production, and value of output per acre of some commodities, indicate astonishingly big yields; and yet these results are now realized on lands that were more often than otherwise submerged and the haunts principally of wild creatures not so long ago.

Not many years back, habitations about the shores of Lake Okeechobee were few and far between, and were mostly the huts of fishermen—the lake teeming with bass and catfish that are much in demand. Today, thriving and attractive communities border the Lake on reclaimed lands, and excellent highways and railways afford means of access and services that were lacking in the earlier days when the Everglades Drainage District was called into being by the Legislature of Florida.

The six fine hurricane gates that the Army engineers have installed at a like number of canals are high enough and strong enough to resist the impact of any probable storm waves. Ordinarily, these power-driven gates will be operated to permit water either to escape from the lake into the drainage canals to provide irrigation for the reclaimed lands or, conversely, to flow from flooded lands into the lake when the level of the latter has dropped so as to make that reversal of flow possible and desirable. At other points in the levee system there are culverts which are designed not only to facilitate the drainage of outlying lands by admitting their excess water into the lake but also to allow lake water to move outward to the same lands when they may need it for irrigation, for the quenching of ground fires, or for combating infrequent frosts that threaten the cultivated areas.

The four drainage canals that lead from the lake to the Atlantic are connected by secondary canals, and the secondary canals are linked with subsidiary ditches. The whole network is arranged either to dispose of the heavy precipitation characteristic of that part of Florida or to promote, during the drier months of the year, the distribution of water essential to nourishing the growing crops. The ground-water level has to be maintained within about 3 feet of the surface because of the spongy nature of the muck soil and its tendency to dry out rapidly under the hot sun and the action of rapid evaporation. When dry, the soil ignites easily and burns stubbornly.

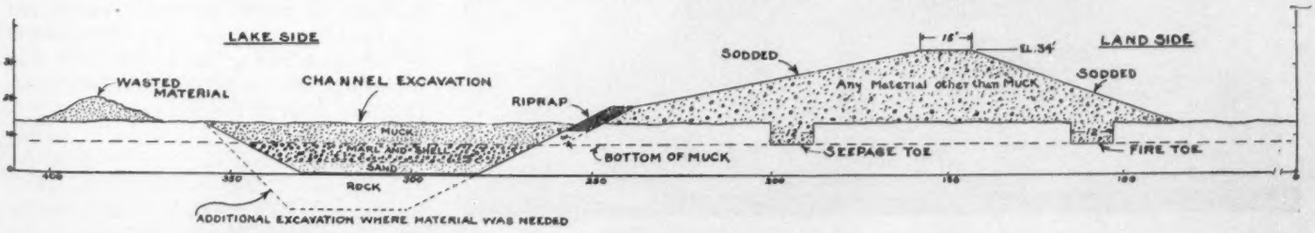


LOCATION MAP

Here is shown Lake Okeechobee's relation to the great drainage area on the north and the Everglades on the south. The locations of the four main drainage canals running southeast from the lake are indicated. The Saint Lucie Canal and the Caloosahatchee River are primarily flood-control outlets for Lake Okeechobee. The latter is said to be the second largest body of fresh water wholly within the United States.

Of the many millions of dollars that have latterly been expended by the Government on public works of a major nature, none is likely to recompense the nation as a whole sooner than the sum spent upon the Everglades Drainage District. That money will safeguard an undertaking of great established value, and will make it economically wise to push steadily onward in adapting more and more of that region to man's needs. The drainage of the Everglades is no longer a dream provoking skepticism, as it once seemed, but is now a material accomplishment of splendid proportions that will attain added dimensions with each succeeding decade.

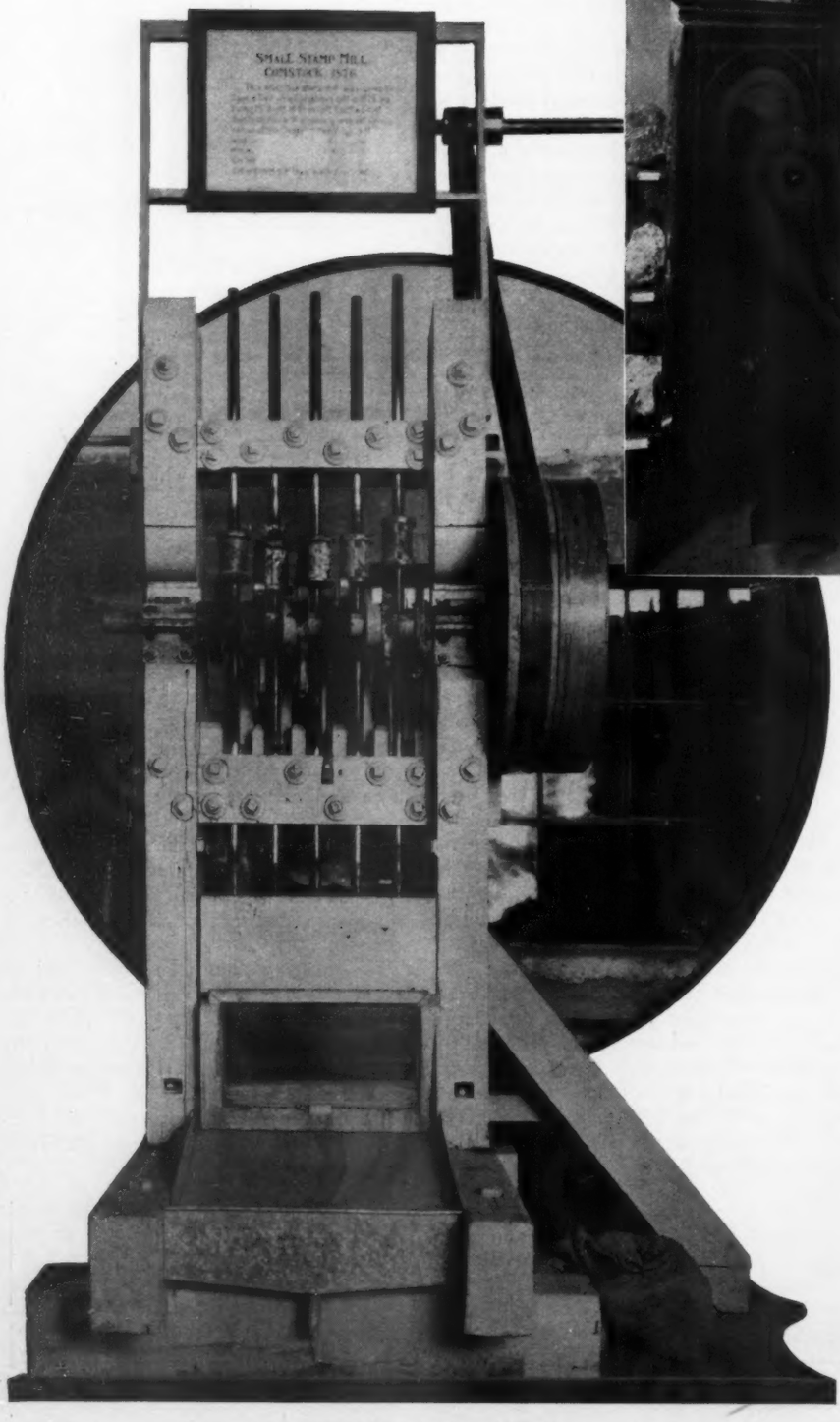
The work on Lake Okeechobee and on the two flood-control outlets has been under the direction of Lieut. Col. Earl North, Corps of Engineers, U. S. Army, and the State of Florida has been represented by its chief drainage engineer, F. C. Elliot, who long has been identified with the administrative body that has charge of the Everglades Drainage District.



TYPICAL TRANSVERSE SECTION

Drawing showing the new levee system and the associate navigation channel along the southern edge of Lake Okeechobee. The channel extends from the Saint Lucie Canal to the Caloosahatchee Canal, and affords a sheltered route for craft drawing not more than 6 feet of water.

A Relic of the Comstock Lode



COMSTOCK MEMENTOS

Two articles from the Mackay Museum at the University of Nevada. The safe was used by John W. Mackay when he was directing operations on the Comstock Lode. It now harbors the school's collection of high-grade ores. The stamp mill was given by James G. Fair to his 5-year-old son as a Christmas present and was used by the lad to stamp out gold for spending money from rich ores given him by his father.

ONE of the prized possessions of the museum at the Mackay School of Mines of the University of Nevada, at Reno, is a Burleigh rock drill that was used in the drilling of the Sutro Tunnel probably between 1874 and 1878. Last spring, two senior students, Bert G. Cummings and Marion C. Brooks, were given as a class assignment the work of studying the drill and preparing independent reports on it. Through the courtesy of Prof. Jay A. Carpenter, acting director of the Mackay School of Mines, the two reports and the photographs that accompanied them have been made available to COMPRESSED AIR MAGAZINE. Some of this material has been included in the present article.

The Sutro Tunnel was an adjunct to the Comstock Lode which yielded more than $400,000,000 in gold and silver, paid $126,000,000 in dividends, and gave rise to some of the most tumultuous happenings in the history of American mining. Its outpourings of metal not only contributed measurably to the financing of the Federal Government during the trying Civil War period but also caused many nations to demonetize silver in the belief that the Comstock treasure chest was so inexhaustible that it would flood the world with silver. The Comstock also founded some great American family fortunes, among which were those of the Hearsts and the Mackays.

The Comstock Lode lies in Nevada, close to the California line. At the time of its finding it was in the territory of Utah. It laid undiscovered during the nine years that placer miners swarmed over the streams

and gulches that led downward from it. Two gold panners, Peter O'Riley and Patrick McLaughlin, found it accidentally on June 8, 1859, while deepening a spring in an effort to obtain more water with which to wash the loose surface soil from the hillside. At a depth of 4 feet they encountered yellowish sand containing bits of quartz and a black mineral that they could not identify. Upon washing some of the material they were astonished to find it liberally sprinkled with gold. The black mineral, it developed later, was argentite, the sulphide of silver.

Chance decreed that Henry Comstock, a trapper and trader, should choose the moment of the strike to ride up the hill on horseback, and he quickly established himself as the first great opportunist in American mining annals. Seeing the gold, he cowed the discoverers with an untrue tale that he had homesteaded the land, and they agreed to share their find with him and his partner, Emanuel Penrod. Comstock grabbed an additional 100 feet of the 1,400-foot claim for the right to use the spring water. Two more men were later given shares in return for contributing two *arrastres*, or Mexican grinding mills, and two horses to work them. The domineering Comstock took over the management of the operations, and his name was given to the lode. Neither he nor any of the others recognized the true value of the deposit, however, and they all sold out for small sums before its real worth was known.

Although many mines were profitable from the start, the discovery of the so-called "Big Bonanza" in 1871 signalized the tapping of the treasure trove. Curiously enough, this, too, was struck by accident, having been uncovered by a drift that extended beyond the boundary line of the Gould and Curry Mine. The rewards were reaped jointly by the Consolidated Virginia and California mines, which were controlled by John W. Mackay, James G. Fair, James C. Flood, and William S. O'Brien. Together, those properties produced $150,000,000 in 22 years and paid $78,000,000 in dividends. In the 5-year period 1874-1879 they yielded 1,000,000 tons of ore that averaged $100 a ton in recoverable gold and silver.

Water had handicapped mining operations almost from the start; and, for the purpose of alleviating this trouble, Adolph Sutro conceived the idea of driving a drainage tunnel. In the spring of 1860 he began negotiations with the mines, the territorial officials, and, finally, with the Federal Government for contracts and concessions, but work was not started until October, 1869. The tunnel, which is really an adit, extends from the Carson River Valley into Mt. Davidson for a distance of 20,145 feet, or nearly 4 miles. It intersects the lode at the Savage Shaft at a depth of 1,895 feet below the outcrop. It was not completed until July 18, 1878, by which time the Comstock had passed its heyday. Although as much as 7,000 gallons of water at times flowed out of the tunnel, most of the mines were by then either working considerably below its level or had ceased operations. The last deep mining was done in 1886. All told, Sutro expended $4,500,000 on his scheme, of which $2,096,566 represented the actual cost of tunnel driving.

Sutro, a member of a family of Jewish immigrants from Prussia, left his Baltimore home when only twenty years old to join the gold rush. Upon reaching the scene, however, he chose not to engage in mining at once, although he had attended some of the best technical schools in Germany and was better equipped for mining than most of those that were there. Instead, he opened a tobacco shop. As time went on, he recognized that operations were being carried on with no regard to the future and that a low-level tunnel was essential to successful deep mining. When he proposed one, however, he was characterized as insane, and nine years elapsed before he could secure the necessary approvals. Sutro, was in financial difficulties several times during its construction, but in the end the tunnel netted him some money. This he invested in San Francisco real estate and became wealthy. Sutro Heights in that city was named after him.

While it largely failed to accomplish its purpose, the Sutro Tunnel was an outstanding piece of construction for its time. One writer has stated that it was finished "only after Sutro had surmounted obstacles of both God-made and man-made origin, both types of which were a credit to their originators." In places the ground swelled so badly that it broke 18x14-inch timber sets three hours after they were placed. One stretch of tunnel floor was uplifted to such and extent that in three months it was cut down 18 inches seven separate times, or a total of 10½ feet. The workmen had to contend with hot water, hot ground, and poor air, the distance from the heading to the nearest ventilating shaft being as much as 2 miles. It was only by keeping ice water and blocks of ice close at hand that any work could be done; and it is reported that the mules employed in the bore for haulage would lay their heads on the ice and would not leave it until they were forcibly dragged away. Many of those animals went "loco" from the heat.

The tunnel measures 10 feet high by 14 feet wide, inside the timbers, and was divided into two sections by a central row of supporting posts. Drilling was done by hand until September, 1872, when diamond drilling was tried. It was not very satisfactory, and was discontinued. In April, 1874, Burleigh drills were introduced. Compressed air for operating them was furnished by a compressor imported from Belgium.

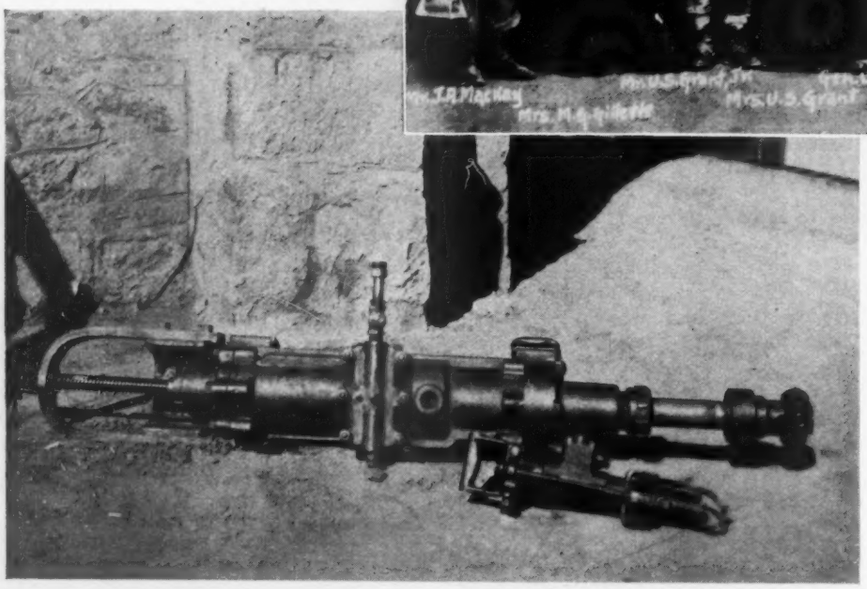
Just why mechanical drills were not used sooner is hard to understand, as Charles Burleigh had furnished 40 of them in 1866 for driving the Hoosac railroad tunnel in Massachusetts, where they had performed successfully after the initial troubles that

OLD PAY CHECKS

The money with which Mackay, Fair, and their associates bought the Consolidated Virginia and California mines that afterwards yielded them millions came from the Hale & Norcross Mine. As joint superintendents, Mackay and Fair developed that property by efficient mining methods. Shown here are two Hale & Norcross pay checks, one signed by each superintendent.

GRANT AT COMSTOCK

The Federal Government was materially aided during the Civil War period by wealth from the Comstock Lode, and in 1879 Gen. U. S. Grant visited it with his wife and son. Mackay and Fair were hosts to his party. The inscription beneath Mackay's picture in this old photograph erroneously gives his second initial as "A." It should be "W."



THE BURLEIGH DRILL

This machine is 6 feet long, weighs 550 pounds, has a 14-inch stroke, and can drill a 1⅞-inch hole at the rate of 1.22 inches per minute when operated with air at 60 to 70 pounds pressure. The piston is 4½ inches in diameter. The complete piston assembly, including the chuck, weighs 125 pounds and reciprocates at the rate of 300 blows per minute. Shown with the Burleigh drill for comparison as to size is a hand-held drill of more recent manufacture.

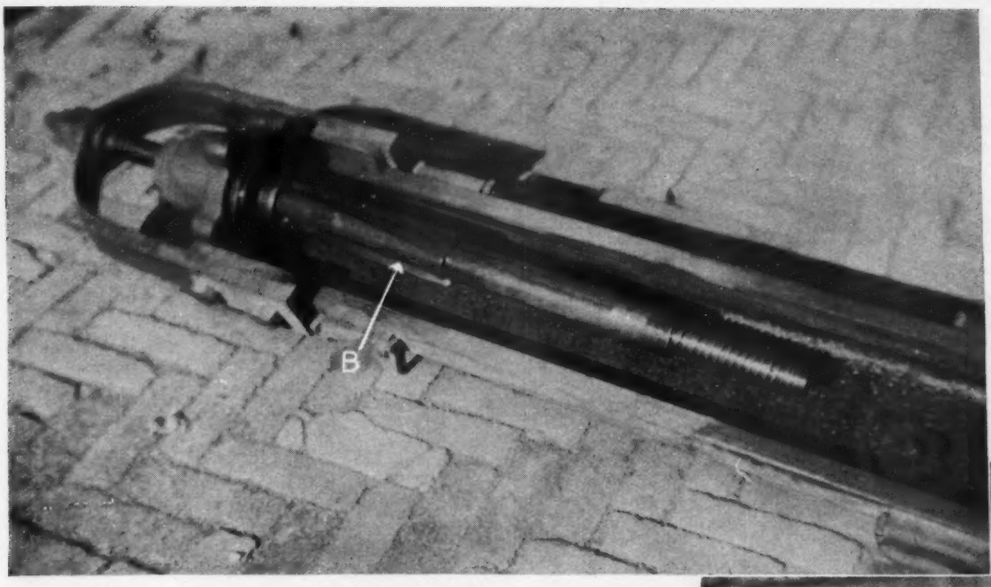
caused excessive breakage had been ironed out. A possible explanation for this is found in correspondence, now in the archives of the Mackay School of Mines, which shows that in 1873 the Burleigh drill patents and rights to manufacture it were held by one Thomas Brown of 96 Newgate Street, London, England. Many letters crossed the Atlantic before Sutro purchased the drills.

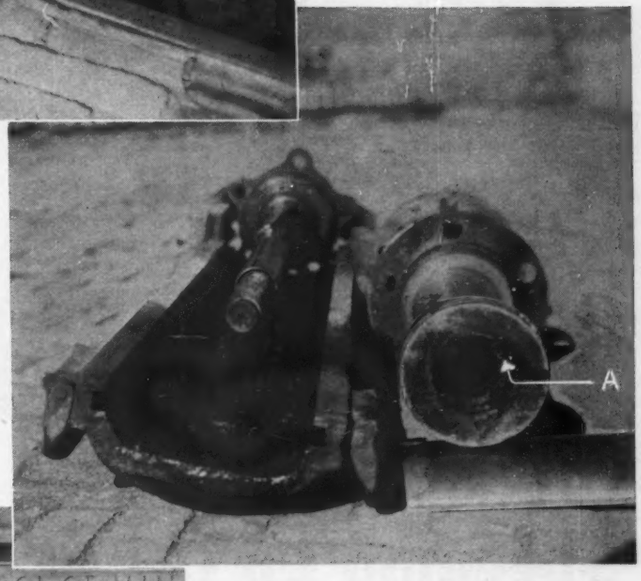
These records indicate that eight machines were bought. They were at first quoted at 1,000 pounds sterling for the lot, or about $600 apiece. Later they were offered for 84 pounds, or about $420 each, at Marseilles, France. With each four drills went a carriage, on which to mount them, at a further cost of $600. It appears, therefore, that Sutro's investment, exclusive of pipe, fittings, hose, etc., was around $4,500. In addition, he paid the freight charges. It is evident that the drills must have been highly recommended to warrant such an expenditure, especially as Sutro was dealing with a foreign concern with which he could have no immediate contact in case operating troubles developed.

The Sutro Tunnel was the second large work of its kind in America on which mechanical drills were used. Some rock-drill historians believe that the Burleigh drills did not complete the job and that they were supplanted by Ingersoll drills; but this may or may not be true. Certain it is that progress in the tunnel was faster after hand work gave way to machine drilling. In *Tunneling*, by Henry S. Drinker, it is stated that under ordinary conditions and with one 7-hour shift a day the average monthly advance was 50 feet. When working "under pressure," which probably means more hours per day, an average monthly mark of 100 feet was attained. With mechanical drills the monthly progress rose to 400 feet under ordinary conditions. Another source of information records the average monthly advance as 310 feet in 1875, 306 feet in 1876, 260 feet in 1877, and 235 feet in 1878. As mechanical drills were introduced in 1874, it is very likely that they were in use all that time. The slowing up in progress in 1877 and 1878 is explained by the fact that two zones of unstable ground, one 300 feet and the other 400 feet long, were encountered during those years.

The study of the Burleigh drill conducted at the Mackay School of Mines involved dismantling it, comparing its construction with that of later piston drills and with modern drills, reassembling it, and running it. The first striking feature about the drill is its size, which is as follows: length, 6 feet; weight, 550 pounds; diameter of piston, 4½ inches; length of stroke, 14 inches.

The second interesting fact determined was that the weight of the entire piston assembly is approximately 125 pounds, or nearly one-fourth the total drill weight, as compared with the 5 per cent proportion in the case of a modern hammer type of drill. The great weight, coupled with the fact that the air pressure supplied the drill amounted to only 60 to 70 pounds, as against the 90 to 100 pounds used today, explains in part why the Burleigh delivered only 300 blows per minute in contrast to the more than 2,000 blows of present-day machines. The same facts make it possible to believe the statement, contained in an early advertisement in the *Mining & Scientific Press*, that a Burleigh drill, if anchored solidly, could move a 60-ton block of granite along a smooth floor.



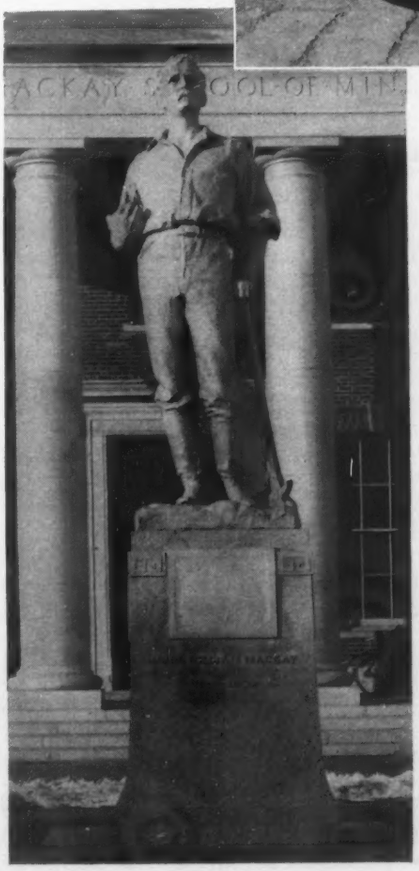


THE AUTOMATIC FEED

The Burleigh drills used in the Sutro Tunnel were equipped with an automatic feeding mechanism. Other early drills also had this feature, which was, however, abandoned for cranking because the rate of feeding could not be controlled to meet changing rock conditions. The Burleigh drill was fed forward during the back stroke of the piston. The lugs *A* inside the rear end of the piston (right) traveled in the grooves *B* in the shell encasing the feed screw (above), causing the tube to turn, the piston previously having been given a one-eighth turn by the rifle bar. At the back end of this grooved tube is a ratchet through which the rotation was transmitted to the feed nut, causing the whole drill assembly to move forward on the feed screw. To withdraw the drill from the hole, the feed nut was held stationary by means of a spanner wrench and the feed screw turned by a handle applied to a nut at its extreme rear end. This nut may be clearly seen in the photograph of the assembled drill reproduced on the preceding page.

The greatest cause for amazement, however, was the discovery that this drill, made more than 60 years ago, fed the drill steel forward automatically. This will surprise most users of rock drills who have considered the automatic feed to be a development of the past few years. But drill designers and others familiar with the evolution of modern drills state that all the early machines incorporated this feature. It was discontinued because the rate of feeding was the same no matter whether the drill was working in hard or soft ground. This obviously led to difficulties, and hand cranking was substituted because it was more satisfactory. Modern automatic feed mechanisms are arranged so that the rate of feeding can be varied with changing rock conditions, and they are also reversible.

Mention was previously made of two drill carriages which were obtained by Sutro, and this brings out the little-known fact that such multiple drill mountings were in use as long ago as 1874. Each carriage supported four drills; and as the total weight to be handled was more than a ton, it very likely was moved on rails, although no information is available on this point. It may well be that the carriages were abandoned after a trial, for, had they proved successful, they would no doubt have been used more extensively than they were during the following 40 or 50 years. The fact is that the drill carriage or jumbo, as we know it today, is distinctly a modern development.



Upon putting the drill together again, the students ran it for a time and found that it would drill a 1⅞-inch hole at the rate of 1.22 inches per minute. They completed their investigation with a feeling of admiration for the inventive and manufacturing genius of a past era that produced such truly remarkable machines, all things considered. With regard to the drill itself, one of the co-authors wrote in conclusion: "In spite of its antiquity, we doff our hats to the old drill. It was a monarch in its day, and it did its job well."

STATUE OF MACKAY

John W. Mackay, outstanding among the four "Bonanza Kings" and later prominent as the founder of the Postal Telegraph Company, died in 1902. Six years later his widow and his son Clarence erected, as a memorial to him, a building to house the School of Mines at the University of Nevada. The institution has since been known as the Mackay School of Mines, and has received numerous additional gifts from the Mackay family. The picture shows the entrance to the school and a statue of John W. Mackay by Gutzon Borglum.

CROSS POLLINATION

Female flowers or cones of a pine tree (above) are inclosed in canvas bags shortly before the wind begins to blow the male pollen about. After being tested for germination, male pollen from a selected tree is introduced to the female flowers by injection with a hypodermic syringe, as shown at the left.

Speeding Up Forest Growth

C. F. Greeves-Carpenter

THE virgin forests of the United States are being decreased annually to the extent of 25,000,000,000 cubic feet of wood. Less than one-sixth of the total forested area that covered the states when our forefathers landed is left, and this is now being used up three times as rapidly as it is being replaced. The Pacific Coast is at present the most densely timbered section of the country.

In 1925, James G. Eddy, descendant of a long line of practical lumbermen, became vastly interested in the late Luther Burbank's plant-breeding achievements, and concluded that what was possible with the smaller-growing plants should not be beyond the realm of accomplishment with trees. To test his theory, he established the Eddy Tree Breeding Station at Placerville, Calif., and financed it entirely during its formative years. During the spring of 1932, Mr. Eddy turned the control of the organization over to a national board of trustees, of which he became a member. At the same time its name was changed to the Institute of Forest Genetics, the first organization in the United States to devote itself exclusively to the development of inherently superior timber trees.

In 1935, the institute deeded the property to the United States, and the work is now administered through the Branch of Research of the Forest Service. The board of trustees, though, continues to function in an advisory capacity. Provision was made in the deed of gift for the return of the property to the board if at any time Government funds are not made available for this special research in forest genetics. Naturally, the work is national in scope; but in order to facilitate administration problems, the institute is affiliated with the California Forest Experiment Station.

The objectives of the institute are: To reduce materially the time required by nature under usual conditions to produce trees of 70-80 feet height with a diameter of 16 inches (the minimum size for saw logs) and trees that are relatively free of heavy branches and, therefore, of knots. It is planned to develop or isolate trees that are as resistant as possible to attack by insects and fungi; and, what is of equal importance, to produce strains of trees that will come up to specifications and thrive throughout a wide and differing climatic area.

To meet the first of these requirements, trees will have to be developed which will grow fast enough to make them profitable to the individual landowners that now operate four-fifths of the nation's timberlands. In the northern latitudes, it takes from 50 to 100 years or more for trees to reach commercial dimensions, and that is much too long a time for capital and lands to be tied up, particularly if such trees could be grown in half that time.

It has been estimated that 81,000,000 acres of devastated timberland must be reforested if forest consumption and forest growth are to be equalized. As wood is so essential to our existence, it is vitally important that some steps be taken to strike a balance as quickly as possible. Such was the problem that confronted the scientists when they first started their researches. By scientific selection of species, strains, and progenies, and by hybridization (methods successfully employed in the production of

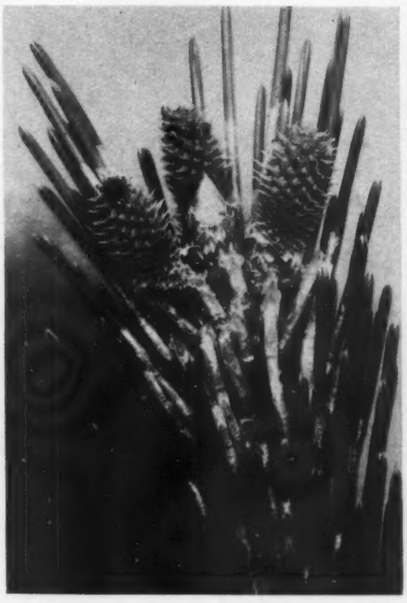
superior strains of many of the lower-growing plants and of some animals) their efforts have already met with much success. While their aims are high, they are far from being unattainable. Their researches up to the present indicate that what has been accomplished particularly with fruits and ornamental trees may yet be achieved with forest trees.

The program is to develop and to intensify specific, useful tree characteristics. For instance, wood of great strength and durability is desirable for structural work; wood that can be handled with facility is sought by the planing mills; box manufacturers require soft wood that will not easily split; and the wood-pulp industry is interested in the length and quality of the fiber. Multitudinous, indeed, are the problems to be worked out at the institute. Many of the seedlings grown at Placerville are baked in an electric oven so that their dry weights may be compared. This oven is also used as an incubator in which pollen is germinated. A dehydrator is available for drying pine cones so that they will open and shed their seeds.

The experimental area comprises 82 acres of land located in the Sierra Nevada foothills at an elevation of 2,700 feet. This site was chosen because its moderate climate will permit the growth of species from many latitudes. The soil is a uniform, deep, residual loam, and there is a plentiful supply of water for irrigation. The average annual rainfall is about 45 inches; and the extremes of recorded temperatures in the past ten years have been 16°F. and 102°F.

For the present, the institute has concentrated its Placerville investigations on pines, as they have the widest geographic distribution and are the most useful of the softwoods. Their numerous species offer wide scope for effecting combinations which may finally produce the ideal softwoods. A small tract of land in the California State Nursery at Davis has been leased for 25 years, and this is being used for similar experimental work with timber walnut trees because, commercially, they occupy as important a place among the hardwoods as the pines do in the softwood group.

The institute enlisted the coöperation of foresters and others the world over to obtain the 100 or more species and varieties of pines which were planted, and these came from 40 different countries. The fastest-growing species were selected from seed taken from different places within its natural range, which, of course, allows for a comparison of geographic strains. Height, diameter, and branch measurements were recorded regularly, and in the second year such trees as were judged to be vigorous or normal in their growth activities were transplanted to the arboretum.



YELLOW-PINE CONES

These blossoms are turning into cones after pollination. Two growing seasons are required for the seed to mature.

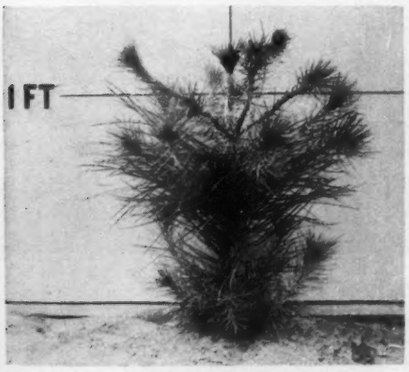
By a special process of selection of parent trees according to the performance of their progeny, a number of progeny tests have been conducted which have revealed the existence of local strains within a species and have also shown that inherent vigor varies greatly from tree to tree. Once again the factor of seed selection has proved of great value; and these tests will provide an important and reliable seed source. Plantations of rapidly growing strains are to be established in localities where the danger of pollination from unselected trees is entirely removed. Obviously, these tests have a most important bearing on hybridization experiments, and it is equally certain that the timber trees that meet the institute's requirements will be the result of both selection and hybridization.

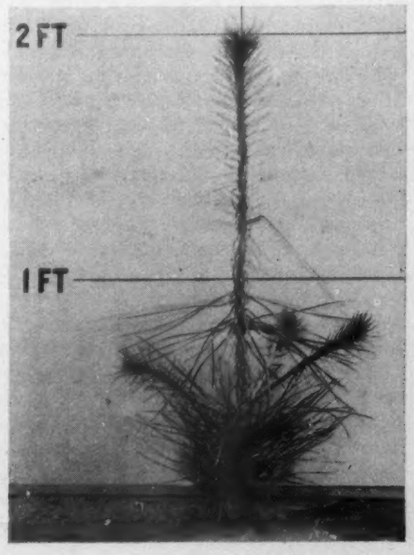
The institute has developed the art of cross-pollination of pines to a high degree. The procedure is to cover the female flower (young cone) with a finely woven canvas bag having a small celluloid window through which it may be observed. This bagging is done two weeks or so before the male pollen ordinarily begins to be blown about by the wind. The next step is the gathering and drying of the nearly ripe catkins from the desired tree. The dried catkins are then shaken in a tight container, and a portion of each lot of pollen is subjected to a germination test before the balance is introduced to the female flowers on selected trees. The latter act is performed when the female flowers have opened, and is done without removing the protective bag, usually by means of a sterilized hypodermic needle and syringe—the punctured canvas being immediately repaired with adhesive tape.

It is a somewhat difficult matter to fix the type in hybridization experiments, as this often requires much inbreeding and selection before the strain will come true from seed. Experimental work has been done, however, by the institute staff in budding and grafting pines in a definite plan to reproduce them vegetatively and to develop, eventually, a technique that will make this possible in commercial forestry projects.

The institute has a unique and well-equipped underground storage vault for keeping pollen under even, cool temperatures and for the long-time storage of seed. It is the intention later on to establish small testing stations in various forest regions of this country so that the actual field performance of the new strains may be determined.

To date, the fastest growing of the pines have proved to be: Monterey Pine, native of California, Spreading Leaf Pine from Mexico, Cluster Pine from France, Italian Stone Pine from Italy, Slash Pine and Loblolly Pine from the southern states, and Coulter Pine from Southern California.





POOR AND GOOD TIMBER TREES

Two western-pine seedlings of the same age that exhibit widely differing tendencies of growth. The one on the left is plainly not going to be as good a timber producer as the one on the right, which is developing a long stem. One of the objects of the Institute of Forest Genetics is to cultivate strains that have uniformly good growth habits.

PORTION OF QUARRY

This picture was taken at a time when native workmen were being instructed in the operation of the drills. This accounts for the fact that holes are being drilled without regard to locating them where they will be most effective for blasting.

Basalt for Egyptian Roads

BASALTIC rocks, which may be loosely classified as dark-colored, fine-grained rocks of igneous origin, are highly regarded for roadbuilding purposes in Egypt. They are desirable because of their high crushing strength and also because when they are altered under the influence of weathering there are developed secondary minerals which serve to bind the mass together and to make the highway more compact. The entire supply of basalt for Egyptian road-building comes from the Abu Zaabal quarries, which are situated about 9 miles northeast of Cairo. The rock was intruded as a volcanic neck, which overflowed in the form of a sheet upon reaching the surface.

In 1936 the Department of Survey and Mines of the Egyptian Government took in hand the operation of the quarry, and has since developed a plant and organization for getting out the rock and reducing it to the several sizes needed for road-construction purposes. A quarry face some 1,300 feet long and 46 feet deep has been established, and modern equipment has been installed throughout.

The power plant consists of two diesel-engine-driven generators, each of 500-kw. capacity. They produce alternating current at 3,300 volts and of 50 cycles frequency. For economic reasons, these generators have been set up in the power house of the Egyptian State Railways which is approximately 2 miles from the quarry. The power is transmitted at 3,300 volts to the quarry, where it is stepped down to 220 volts for lighting purposes by two 15-kva. transformers and to 550 volts for running motors by two 400-kva. transformers.

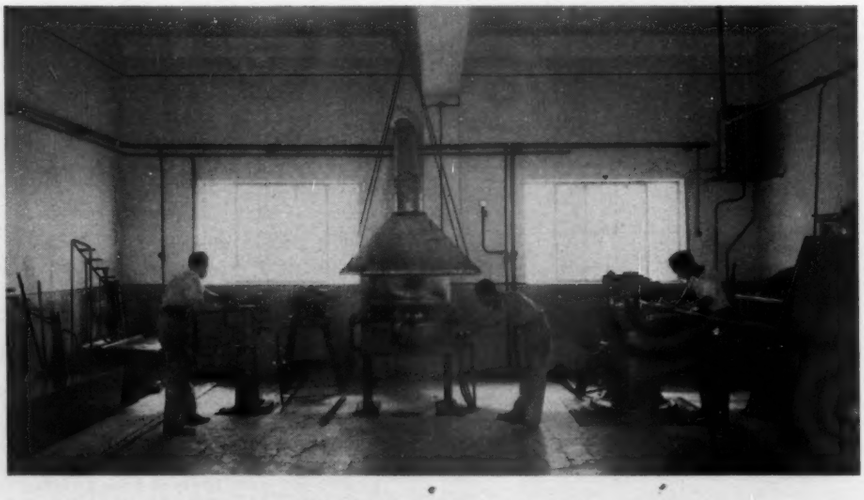
Drilling is done with two Ingersoll-Rand drifters mounted on tripods and with six Jackhamers. Drill steel is reconditioned in a well-laid-out blacksmith shop that is fully equipped with an I-R No. 40 drill-steel sharpener, an oil-fired furnace, and a pedestal grinder for treating shanks. Compressed air is furnished by two Ingersoll-Rand 2-stage compressors, each of 520-cfm. capacity and driven by a direct-connected, 105-hp. synchronous motor. The air is discharged at 100 pounds pressure.

Quarried rock is delivered to the crushing and screening plant in railroad cars that travel on tracks having a grade of 1.2 per cent. They are drawn by means of an endless overhead rope that is operated by a 35-hp. motor. The capacity of the system is 200 tons per hour when running at a speed of 5 miles per hour. The transportation plant was made by Beckett & Anderson, Ltd., of Glasgow, Scotland.

The crushing and screening plant was built and erected by Miag, Braunschweig, Germany. It contains two primary crushers, each of 40 tons per hour capacity. They will handle rocks up to 16 inches in size, and the material is dumped into them by means of two automatic feeders. The crushed rock is screened and the rejects sent to two secondary crushers. Material that fails to pass through a second screen goes to rolls, where it is further reduced in size.

The crushing machinery is driven by 165- and 50-hp. motors. The screens are of the vibratory type and are designed to produce materials of the following sizes: 0.2 to 0.4 inch; 0.4 to 0.8 inch; and 1 to 2 inches. These are stored in concrete bins from which supplies can be drawn through gates as needed. The stone is transported in 5½-ton trucks to a stocking yard alongside the Ismailia Canal, approximately a mile from the quarry. As this canal connects most of the important cities and towns in Egypt, the material can be readily delivered for use in almost any part of the country.

The plant has a daily capacity of 640 tons of crushed and screened stone. Hassan Effendi Hilmy is resident engineer in charge of the operations for the Egyptian Government.



THE BLACKSMITH SHOP

From left to right, the men are working at a pedestal grinder, an oil-fired furnace, and a No. 40 drill-steel sharpener. At the extreme left are quenching tanks. This shop is noteworthy for its clean, orderly appearance.

SOUND MAKERS

These illustrations show equipment used in the San Francisco studio of the National Broadcasting Company to produce various sound effects. In the picture below, the girl at the left is operating a hand pump to inflate a basket-ball bladder that serves to simulate the sounds of explosions. The other girl is blowing in a tube that is inserted in a basin of water to create the effect of bubbles rising from a diver working underwater. At the right is the 3-turntable phonograph which can reproduce three records at a time to give mingled sound effects.

Producing Sound Effects for the Radio

IN THAT realm of make-believe, the movies, all sorts of devices have been brought into play to give sound effects. Now the radio is resorting to similar tactics, and the better-equipped studios are well stocked with instruments and gadgets for producing almost every kind of noise that the great variety of programs may call for. The larger broadcasting stations employ a sound technician and several assistants to design, build, and operate these appliances.

Formerly many of these sounds only remotely simulated the real ones, but the current trend is towards realism. Accordingly, wherever it is possible to do so, the actual sounds are duplicated by means similar to those used in real life, with due allowance for the diminution of volume desired.

Compressed air is utilized in making many of these sounds. For example, where the script calls for a salvage operation, with divers working underwater, the effect is obtained by blowing air through a short length of tube into a basin of water. If the sound is to be prolonged, an air compressor is used, otherwise a technician inserts the tube in his mouth and furnishes the necessary air power. The sound of the diver entering or emerging from the water is made by plunging a wooden float in and out of the vessel.

Where a dynamite explosion or the discharge of a cannon is to be broadcast, the sound is produced by placing a handful of small shot in a basket-ball bladder and then inflating it until it is about 14 inches in diameter. With the bladder held tight under his left arm, the sound technician strikes it a sharp upward blow at the point where the shot has accumulated. Thus propelled, the leaden pellets strike the upper wall of the bag, making a sound that is closely akin to the blast or discharge of a cannon. Even the reverberations that follow an actual explosion are simulated as the shot falls back and bounces around in the lower part of the rubber sphere before coming to rest. Repeated striking of the bag has the auditory effect of successive explosions. The method just described is used to simulate the blasts and shots that are often heard in such plays as *Death Valley Days* and *Winning of the West.*

Many sounds that are used with some frequency are recorded on phonograph records so that they can be reproduced whenever occasion demands. This is particularly true where it is not possible to create the actual sounds in the studio each time they are required and where no satisfactory means of duplicating them has been found. In this category are the sounds of riveting hammers, rock drills, and air compressors.

An accompanying illustration shows the phonograph, or sound-reproducing machine, that is in use in the San Francisco studio of the National Broadcasting Company. It has three turntables, and three records can be played alternately or simultaneously. One of the records has two tracks which reproduce the sounds of air-driven tools on the one hand and, on the other, the sounds of those tools plus that of an air compressor in the background. This record will make these sounds for 45 seconds. If the script calls for a longer period, a duplicate record is placed on a second turntable and one follows the other. In this manner the sounds can be prolonged indefinitely; and by using the three turntables at the same time, the effect of mingled noises can be obtained. For example, it is possible to create the effect of rock drills running on a construction job, with blasts taking place intermittently and with workmen shouting.

Electric Capstan Serves as Pile Driver

SINKING piles by means of an electric capstan sounds like a novel procedure, but it is being done in connection with the building of a railway and vehicular bridge that is part of the harbor-improvement work now underway at Cochin, India. The bridge will link Willingdon Island with the mainland on the Ernakulam side, and will consist of seventeen spans with a total length of 2,040 feet. "A feature of the bridge," writes the American Consul at Madras, "is the method employed in placing the piling. It appears that screws of cast iron with blades varying in diameter from 6½ to 8½ feet (according to the load they will have to distribute) are being used, and each pile is being screwed down to a depth of nearly 80 feet below the surface of the water by means of an electrically operated capstan."

THE GENIUS OF PARSONS

THE invention of the steam turbine by Sir Charles Parsons was the direct outgrowth of experiments conducted by him with the aim of propelling boats with compressed air. This little-known fact was included in a memorial lecture delivered by Gerald Stoney, a former associate of the noted inventor, before the Institute of Electrical Engineers in England on November 25, last. A model of such a boat is still preserved. The propeller was inclosed in a double cylindrical housing carrying blades against which a jet of air was to impinge. The principle of operation involved was roughly similar to that of the steam turbine which Parsons conceived in after years.

Mr. Stoney's lecture afforded an insight into Parsons's remarkable mental powers. So far as anyone knew he never had a slide rule, and he was able to make calculations in his head or on paper as rapidly as most people could with such a rule. He never explained the processes he used. Apparently, in some subconscious way he arrived at conclusions that were almost invariably correct. In the early days of turbine manufacture it was his custom to walk into the drawing room with a piece of paper on which he had written the particulars of the blading that he had decided on for a certain machine. The staff never was informed how he determined the proportions of the blading. After 30 years the staff developed a method of designing the blading; but not until Parsons had thoroughly satisfied himself that it was sound was he content to allow it to be used.

Parsons worked with models a lot and, although they were not elaborate, he was able to obtain remarkably accurate results from his experiments with them. He determined the lines of the hull of a ship by towing variously shaped miniature craft in a pond in his garden with the aid of a fishing rod and line. Next he made a larger model and towed it across the cooling pond of his company's Heaton Works by the power of a falling weight. In such simple ways he arrived at the power that would be required to drive the full-sized vessel at maximum speed. When the power was later determined with the help of all available scientific aids, his figures and those of the government authorities checked within 2 or 3 per cent.

OUR RESTLESS SOIL

IN SOMETHING like 18,000,000 years the Continent of North America will be reduced to a general level of 200 feet above the oceans, according to Dr. Alfred C. Lane of Tufts College. This estimate is based on the assumption that there will be no uplifting movements meanwhile. The average elevation of the continent now is 2,000 feet. Actually, as Doctor Lane told the Geological Society of America last month, the reduction to 200 feet will be accomplished in 2,000,000 years, provided the erosive forces maintained their current rate, but denudation will proceed at a slower pace as gradients grow less.

One of the pressing problems confronting the nation is that of soil conservation, and the study of erosion is bringing out many interesting facts. Investigations by the Tennessee Valley Authority experts have established that the South has been denuded more rapidly than some other sections because of the nature of its crops, and this has been corroborated by experiments conducted by the Soil Conservation Service. Dr. Gordon Rittenhouse of that body has proved that land planted with corn and cotton tends to wear away a hundred times as fast as that on which grass and other cover crops are grown. He arrived at this conclusion by planting several strips of soil with various produce and collecting the drainage from each strip in a separate tank, which permitted measurement of the soil carried away. The planted zones were isolated from one another by means of deeply embedded sheets of metal that prevented any movement of moisture between zones.

RUSSIAN GOLD PRODUCTION

ONE of the riddles of Russia is the actual amount of its gold production. For several years, extravagant estimates of the annual output have appeared in print, and it even has been predicted that Russia would soon outstrip South Africa and become the leading gold producer. Latterly, however, it has been definitely determined that authentic information is not being given out by the Russian Government. According to Soviet press reports, the 1936 gold output was 7,289,000 ounces, or roughly one-fifth the total world production. The U. S. Bureau of Mines, however, has officially estimated the 1936 Russian output as 5,240,000 ounces. This is less than half of the South African production for the same year, but exceeds the total for both the United States and Canada.

Meanwhile, reports are being published in British mining journals that conditions in the Russian gold fields are chaotic and that there can be no increase in production until sabotage is curbed and labor becomes more efficient. It is generally understood that the U.S.S.R. had set a goal of 10,000,000 ounces for 1939; but, in view of the prevailing conditions, it is considered extremely unlikely that that mark will be attained.

The fact remains that the Russian gold industry is a huge one. This is borne out by John D. Littlepage, an American mining engineer, who spent ten years as chief engineer of the Soviet gold trust and is now recounting his experiences in *The Saturday Evening Post*. Mr. Littlepage states that he knows the gold-production figures, but that he is not at liberty to reveal them because the Soviet Government prefers not to make them public. He discloses, however, that sizable deposits, both placer and lode, still await development, and that output could be appreciably increased in a short time, if desired. Apparently, however, Russia has slowed up its gold output at least partly by design, preferring not to deplete this natural resource too quickly.

This and That

No Tariff On Air

A recent issue of *Wire and Wire Products*, a British publication, reported that satisfactory tests have been made by a machinery manufacturing concern in Czecho-Slovakia with a new method of tempering steel that utilizes apple juice instead of oil. It is expected that this discovery may prove of practical value, as the oil now being used has to be imported. Apropos the foregoing information, another British trade paper, *Heat-Treatment Journal*, commented as follows: "We sympathize with the inhabitants of Czecho-Slovakia in having to import oil, but why worry about oil for tempering? Air is available everywhere and, so far, has not been subjected to rates or taxes. Forced-air circulating furnaces will do everything good that oil baths can perform, and a lot more besides. It might be worth while investigating these furnaces."

★ ★ ★

Sue for Sleep

Contending that their sleep was being interrupted, 31 residents of Yonkers, N. Y., brought suit to restrain a contractor from night work on a shaft that was being sunk in connection with the Delaware River Aqueduct which will augment New York City's water supply. On December 1, the court granted an injunction restricting blasting and the hoisting of spoil to the hours between 7 a.m. and 7 p.m. A claim for $322,500 damages allegedly resulting to homes from blasting operations was denied for want of evidence, and the court likewise refused to limit the amount of explosives used for each blast.

The suit calls to mind an incident that happened during the construction of a section of New York's new Independent Subway System about ten years ago. An elevator shaft was being sunk on a vacant lot between two apartment houses in the Bronx Borough. One day, although all blasts were carefully covered with heavy mats of woven wire, a rock weighing several pounds came hurtling out of the hole. It described a neat trajectory and disappeared through a window about ten stories above the ground of one of the adjoining structures. The superintendent rushed over to the house to ascertain what damage had been done. There was some delay in determining just which room the rock had entered. When it was located and visited, no one was there, but there was evidence that it had recently been occupied. Minor articles of men's wearing apparel were strewn around, and bureau drawers and a closet door were open. The rock had passed about 2 feet above an unmade bed, crashed into a wall, and fallen to the floor. Inquiry revealed that the room had been sublet by the occupants of the apartment to a young man who worked nights and slept in the daytime. He had been in bed when the stray missile made its impromptu entrance; but he had evidently lost no time in dressing, packing his principal belongings, and getting out. No one saw him leave, and he never came back.

★ ★ ★

Filling Mine Stopes

The average conception of mining is generally one of taking material from the earth, but oftentimes a large portion of the extracted material is returned underground. This is done to fill stopes to provide support for the overhanging rock, thereby permitting the recovery of ore that would otherwise have to be left in place. Coarse rock sorted out of the ore or derived from underground development usually suffices, but this is sometimes supplemented by mill tailings or smelter slag. Occasionally, extraneous material is used. The Hollinger Mine in Canada transports sand 4 miles by aerial tramway and the Lake Shore hauls it in in 8-car trains.

"I'm tired of bouncin' him on my knee when I get home nights!"

★ ★ ★

Dams Doom Mussels?

For several years the salmon industry of the Northwest has expressed its apprehension that the damming of the Columbia River will prevent salmon from reaching their upstream breeding grounds. To accommodate the fish, elaborate lifts have been devised to ferry them over Bonneville Dam. Now the Bureau of Fisheries voices fears that the TVA dam program on the Tennessee River will destroy much of the fish life in that stream by transforming it into a series of still lakes. It is especially concerned about the fresh-water mussel, the shells of which are the chief material for the manufacture of buttons in the United States. In recent years the Tennessee has supplied 5,000,000 pounds of these shells annually.

★ ★ ★

New Diving Record

On December 1, Max E. Nohl, of Milwaukee, Wis., descended 420 feet in the open waters of Lake Michigan, setting a new record for depth of submergence. He wore a flexible rubber diving suit which he had made with the assistance of Capt. John Craig, with whom he will be associated in attempts to salvage the cargoes of several sunken ships which have hitherto been considered out of the reach of divers. As lake water weighs about 62 pounds per cubic foot, Nohl was subjected to a maximum water pressure of approximately 181½ pounds per square inch when on the bottom. He breathed a mixture of helium and oxygen which, as was explained in an article by Robert G. Skerrett in our October, 1937, issue, is instrumental in preventing compressed-air illness or "bends." That this artificial atmosphere proved effective is evident, as Nohl is reported to have suffered no ill effects from his submersion. Instead of receiving his "air" supply through a hose from the surface, as is usually the case, Nohl obtained it from a tank strapped to his back. His descent was in the nature of a test in preparation for proposed efforts to recover valuables from the liner *Merida*, which lies in 220 feet of water off the Virginia Capes, and from the transatlantic steamship *Lusitania*, which rests off the coast of Ireland at a depth of 312 feet.

★ ★ ★

Carbon Monoxide Detectors

According to the National Safety Council, Inc., carbon monoxide in caissons or other enclosures may be detected by lowering a tomato plant. If there is an appreciable amount of the gas present, the plant will wilt in a minute or two. Some safety-equipment supply houses have available small *ampoules* or capsules for making carbon-monoxide tests. These change color if dangerous quantities of the gas are present, and the extent of the change indicates the concentration of the gas.

Rubber for Protective Purposes

A FEW OF THE PRODUCTS

The 50-gallon steel tank at the left is completely insulated with rubber free from seams and welds. At the top are shown dipping baskets and at the right an anode scrap saver, all of which are coated with semihard rubber. The latter measures 4x12x30 inches, and is made to hang in a plating tank from a bus bar. It can carry several hundred pounds of scrap, which is brought in contact with one good anode extending the length of the basket, and is provided with a finely woven canvas bag to prevent scrap impurities from reaching the solution.

FIVE gallons of latex might well be said to be the foundation upon which Collord, Inc., has reared a business which, in 1937, required about 35 tank cars of that material. The company describes itself as a specialist in protective coatings based on rubber, and during the five years of its existence has developed methods of processing latex and produced a variety of materials of which the most important is that used in the lining of tanks for plating and metal-working shops, chemical plants, etc. Tanks designed for purposes of this kind must be insulated against corrosion and acid attack, services which rubber is well qualified to perform because it is highly resistant to most chemicals and does not contaminate the contained solutions.

Rubber-lined tanks, as such, are nothing new; but Collord tanks, according to the company, are an improvement in that the rubber itself has unusual characteristics and the lining is seamless and can be built up to form a homogeneous coat of any desired thickness. The rubber used is in liquid form, and is applied by spraying or dipping, depending upon the work. Brick, concrete, wood, and metal are so treated, the surfaces to be coated first being sandblasted to assure a firm bond between the rubber and the underlying material. In the company's Detroit plant both old and new tanks of any shape and size are made proof against corrosive attack, as well as pipe sections up to 10 feet long and 36 inches in diameter, together with the necessary flanges, elbows, tees, angles, and valves. In the case of old tanks that are too large to transport, the company is prepared to line them on location.

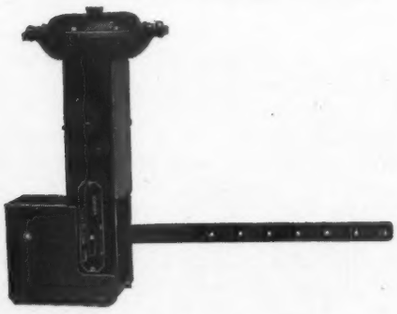
When a tank has received its lining it is given an outside coating of Surfaseal Brushing Rubber, as it is named. This is really a paint of which the vehicle is 100 per cent rubber and the solids 50 per cent rubber. It comes in standard colors—special ones being made to order—and in two grades: No. 2, which is suitable for use in the presence of acids and, therefore, for protective purposes, and No. 3 for decorative purposes. The latter has a harder and glossier finish and is more resistant to sunlight and oils. They have many applications both in the home and in industry, and are especially adapted for painting wood, metal, concrete, and other surfaces which are exposed to moisture and corrosive attack. From two to six coats are required, depending upon service conditions.

Another one of the company's products is Tem-pro-kote, a temporary coating that serves to prevent finely finished metal and other materials from being damaged while in process of manufacture, storage, or transit. Thousands of automobile bumpers, among other things, are protected with this adhesive, which is not infrequently spread over paper in which they are wrapped, thus permitting easy removal.

RUBBER INSIDE AND OUT

There is not a seam, lap, or rough spot in the ⅜-inch-thick lining of this big tank designed for the chemical industry. The outer protective covering is of Surfaseal, and is just as smooth.

Adaptable Lever Motor



AN IMPROVED type of lever motor for the operation of dampers, valves, rheostats, and the like has been designed and put on the market by Taylor Instrument Companies. The Motosteel Even-action Lever Motor, as it is called, is of all-steel, welded construction and very flexible. The lever has a number of uniformly spaced take-off holes that permit adjusting the force or travel of the motor; the lever action can be reversed by transposing fixed and movable pivots and using another lever; the power of either the up or the down stroke can be increased or decreased by means of a spring adjusting nut; and limit stops are provided for both strokes. The unit can be mounted on the floor, wall, or ceiling and operated by a pneumatic controller, an electropneumatic switch, remote manual control, or in parallel with a diaphragm valve or other compressed-air equipment. Three sizes are available with strokes of 3.4 to 6.75 inches, 4.57 to 9 inches, and 6.2 to 12 inches, respectively, and ranging from 17 to 25 inches high.

Gold-Plated Glass

GOLD mirrors for milady's dressing table sounds extravagant, but if recent information received from England is correct, they may be within the reach of even the modest purse. Included in the new gold exhibits that were recently placed in the South African Court of the Imperial Institute, South Kensington, are examples of the work of Prof. Charles S. Gibson who has discovered what is described as a new and easy method of depositing films of pure gold on glass or other surfaces.

To quote Professor Gibson: "Brilliant films, the heaviest of which is only 0.0004 mm. thick, have been deposited chemically on suitably prepared surfaces. By reflected light they appear as massive gold, and by transmitted light show the beautiful greenish-blue color characteristic of thin gold films. They are capable of being polished, but can be produced in such a manner as to render this unnecessary. The thickness can be varied by altering the conditions of the reaction and the quantities of the reactants. Pure gold films are actually more easily produced than those of silver, and chemically they are much more inert."

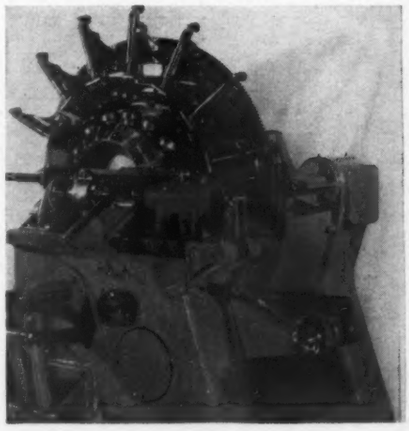
Among the objects loaned to the exhibit by Professor Gibson is a convex mirror 6 inches in diameter, and the gold used to back it cost only one-eighth of a penny! A penny is equivalent to a little more than two cents in United States currency. Aside from luxury articles, the process is believed to have considerable scientific value.

Vacuum-Steam Sterilizer for Canned Products

FRUIT and vegetable juices, which play such an important part in the diet of the American people, are being sterilized during canning by a process that is said to have a number of advantages over the method now commonly employed for this purpose. The Stero-Vac Process, as it is called, together with the necessary machinery, has been developed by the Crown Can Company to the point where it is commercially practicable, and is being used by a well-known packer of citrus-fruit juices in the West.

By the new method the containers are filled in the usual manner, and the valve end, a floating disk, is seamed on preparatory to feeding the cans automatically to the sterilizer, a vertically rotating turret carrying a number of headers with which the upright containers are brought in close contact. At this stage the valve of each can is open so that the contained air can be exhausted by way of the header. As soon as the can in its travel around the machine is tipped just far enough so that the juice almost touches the valve, suction ceases and steam is introduced. The latter treatment, during which the liquid is violently agitated, is continued until the container has made about a three-quarter revolution, when it is automatically lifted from the header. As it is being removed, the floating disk is snapped in place against a special sealing compound and held there by the pressure in the can. Permanent closure is effected immediately afterwards by a clinching unit, which is an integral part of the sterilizer.

In the case of fruit juices, the complete cycle takes about ten seconds—the steam treatment accounting for eight seconds of that time. During this short period the temperature of the liquid is raised from around 110° to 210°F. Condensation of steam in the cans of course leads to some dilution of the contents. This, however, is offset by first boiling the juice in a high vacuum to remove, besides the oxygen and most of the other gases, as much water as is restored during the heating process. Immediately after sterilization the cans are cooled, and they are then under a vacuum



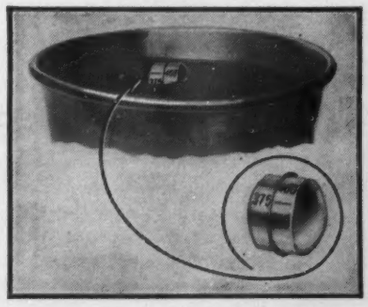
of approximately 22 inches. In actual service, the machine can handle up to 85 containers a minute.

So far the process has been commercially applied only to citrus products, but tests have proved that it is also suitable for the canning of tomato and other vegetable juices, evaporated milk, grain corn, peas, and lima beans. Machines for the treatment of certain vegetables are now in course of development. The advantages of the new method lie, we are told, in what might be termed flash sterilization—the quick heating of the product in the can and in the absence of nearly every trace of oxygen. This, it is claimed, prevents the destruction of Vitamin C and leaves the most delicately flavored foodstuffs unchanged.

Special Thermometer for Hot Liquids

DESIGNED to float, the Thermosphere, a new thermometer offered by the Raytheon Manufacturing Company, facilitates taking the temperature of hot liquids. The instrument is in the form of a small ball with a scale engraved on the outside and a bimetallic mechanism on the inside. The latter is affected by the heat of the liquid in which the thermometer floats and causes it to rotate, the topmost numeral appearing above the surface when it comes to a stop indicating the temperature.

The Thermosphere is of all-metal construction and chromium plated. The standard model is 1¼ inches in diameter and has a scale reading from 350° to 400°F. The manufacturer, however, is prepared to provide special sizes with varying scales ranging anywhere between 50° to 600°F. Aside from many industrial applications, the thermometer is suitable for deep-fat frying.



Industrial Notes

Trico Fuse Manufacturing Company has announced a new line of constant-level oilers for ring and ball bearings of motors, line shafts, pumps, and other machinery having oil wells. The Levomatic, as it is named, is said to keep the oil in the bearing chamber at the desired level, automatically replenishing it as it is consumed with fresh oil from the reservoir. The latter is made of crystal-clear glass and screws into a solid bronze cadmium-plated fitting. This arrangement permits easy removal for refilling, a feature that commends it especially for installations that are in dark or hard-to-get-at places. Other than refilling, the oiler requires no attention. The Levomatic comes in four sizes.

Refuse from mercury plants is the basic material of a new wall finish that has been developed in Russia. It is prepared by sifting the mercury waste and grinding and mixing the product with adhesive substances. Application is made either by brush or air spray. The new paint has the appearance of bronze and can be varied as to shade, the coating having a soft metallic sheen suggestive of silk.

To silence the exhaust noises of diesel and other internal-combustion engines, as well as of blowers and compressors, the Acoustic Division of Burgess Battery Company has developed a new type of muffler. The RMF Series Mufflers, as they are known, have at least 60 per cent more silencing volume than the company's standard heavy-duty muffler, and have been designed especially for use in power stations

in residential districts, in apartment houses, office buildings, hotels, and hospitals where extra quiet is essential. The low- and intermediate-pitched exhaust noises are suppressed in reactance chambers, and the high-pitched ones, which are usually the most difficult to deaden, are absorbed by a special acoustic lining. This consists of a perforated metal tube backed by a heat-resisting, sound-absorbing material and free of baffles or other obstructions that have a tendency to restrict the flow of the exhaust gases, to increase back pressure, and to lower engine efficiency. The new mufflers are constructed of extra-heavy-gauge sheet steel that will withstand the corrosive action of high-temperature gases; they have holes at both ends for the drainage of condensation, oil, and sludge; and are provided with hand holes to facilitate inspection and the removal of the sound-absorbing pads for cleaning.

Colloidal graphite, glycerine, and water are the principal ingredients of a new lubricant for oiling machine parts of rubber.

A screw that cuts its own thread in metals and plastics is offered by the Shakeproof Lock Washer Company.

Warcote is a new floor varnish which is said to be skidproof. It is made by the Warren Refining & Chemical Company and is suitable for both home and industrial use. The finish has a bright waxlike appearance and is resistant to hot water and mild soap solutions.

Steel, from the raw to the finished product, is the subject of a sound movie being produced in technicolor for the United States Steel Corporation. Twenty different plants will serve as settings for this picture, which is being filmed at a cost of more than $200,000 by Technicolor, Inc.

To make pedestrians as well as motorists "crossing-minded," England is experimenting with strips of contrasting colors at street crossings. White-granite inlays, yellow concrete, and alternate black and white slabs are being tried to determine which, if any, will have the desired effect.

A handy little device for tying the ends of wires on concrete forms has been introduced by the Neptune Manufacturing Company. It looks like a button and has a spike on one side and two lugs on the other. The spike is driven into the form, and the end of the wire to be fastened is thrust between the lugs. The button is then twisted with a wrench and, with the wire drawn taut, held in place by a nail.

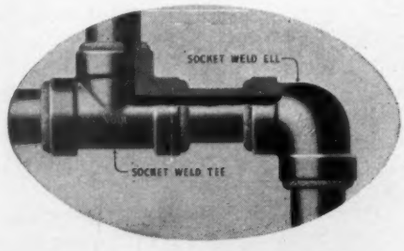
Carpenters and others who continually use tacks and nails in the pursuit of their work, and who make a practice of holding them in their mouths, can do so with impunity provided they get sterilized nails. Germproof nails are available we are told. They are produced by first tumbling them in a revolving drum filled with sawdust, where they are freed of every trace of oil and cleaned and polished. Next they are transferred to another trommel, in which they are tossed about and heated to a temperature of from 500 to 600°F. This is said to be sufficient to destroy all bacteria. The heat gives them a thin film of oxide, and when that acquires a certain shade of blue, the nails are cooled and packed for shipment in kegs lined with sterilized paper.

A new 1-piece, open-side tube bender has been announced by The Imperial Brass Manufacturing Company. It is designed to slip over the tubing without adjustments and can be used to make bends at the end or at any other part of it. It is said to be especially handy in cramped quarters where tubing has been partly connected, permitting protruding ends to be bent without disturbing the sections already in position. The tool is available in four sizes to take tubes of 3/16, 1/4, 5/16, and 3/8 inch outside diameter and to make bends up to 180°. The bending form is calibrated to show degree positions, so that it is a simple

matter to turn out any number of duplicate bends. Imperial No. 364-F, as the bender is designated, is constructed of steel and has a price range of $2.95 to $3.75.

By an ingenious use of sound waves and compressed air, the makers of the Chevrolet automobile have, it is said, measured the combustion-chamber volume of its new engine. In place of the spark plug, a whistle was screwed into the engine, and a similar whistle was attached to the end of a variable-volume chamber. By applying air of like pressure to both, and by varying the volume of the chamber until the whistles had the same pitch, it was possible to arrive at the unknown quantity.

An announcement has been made by the Henry Vogt Machine Company that it has added drop-forged steel socket-weld fittings in a full range of sizes to its line of drop-forged steel valves and fittings. The new fittings are provided with socket ends to receive the pipe so as to make proper alignment certain before and after welding. According to the manufacturer, the socket



construction is such that no weld "icicles" can clog either pipe or fittings, and no matter whether standard, extra-strong, or double extra-strong pipe is used, a smooth passage through both pipe and fittings is assured because the latter are bored to match the inside diameter of the pipe.

Pneumatic Pipe Cleaner

HYDROMATIC Drain Pipe Cleaner is a long name for a small tool that does the work for which it is designed with compressed air. It consists essentially of a 4-inch-diameter cylinder, of a built-in hand pump, and of an air gauge, including five nozzle plugs for pipe openings from ¼ to 2½ inches in size, six expansion plugs to seal other communicating outlets, two adapters for larger orifices, and a special, threaded fitting for the attachment of an air line. The hand pump serves to charge the tool when no compressor is available.

To clear a drain by means of this equipment, it has to be filled with water up to the opening to which the tool, with the right-sized plug attached, can be applied. So sealed, a "shot" of compressed air is delivered to the water by pressing a trigger on the handle of the tool. As water is non-compressible, this shot imparts to it a sharp hammer blow that is transmitted to the material clogging the pipe, effectually removing it. Air at 15 to 40 pounds pressure is usually sufficient to open a drain.

What virtually constitutes an encyclopedia of rock drills and associate equipment—Jackhamers, paving breakers, drifters, Stopehamers, wagon drills, Jackbits, drill steel, sharpeners, furnaces, Calyx and diamond drills, and their accessories—has been published recently by Ingersoll-Rand Company. The catalogue contains 79 pages, and is profusely illustrated with installation and shop views of the various types of equipment described in it. In addition, it includes such useful information as metric conversion tables, friction of air in pipes and hose, horse power required to compress given quantities of air to specified pressures, compressor capacities needed to operate from 1 to 70 drills, etc. Anyone interested can obtain a copy of Catalogue No. 4201 from the company's main office, 11 Broadway, New York, N. Y., or any of its branch offices.

Grand Coulee Dam, which stretches three-quarters of a mile across the Columbia River Valley, is being made crackproof by actually providing it with cracks or "twist gaps," as the engineer calls them. The idea is this. When the dam is finished, and the river is turned in behind it, the water may exert sufficient pressure to cause the structure to give "as much as a quarter of an inch," or enough to put a crack right through the middle. It is to control this force, to prevent it from doing serious damage, that gaps 6 feet wide and running the width and length of the dam are being left in the concrete. These are to be packed with sand, which is to be removed and replaced by concrete as soon as it is definitely established that the "give" has been taken up. According to Frank A. Banks, U. S. Bureau of Reclamation engineer, the Grand Coulee Dam is the first to which the twist-gap principle is being applied.

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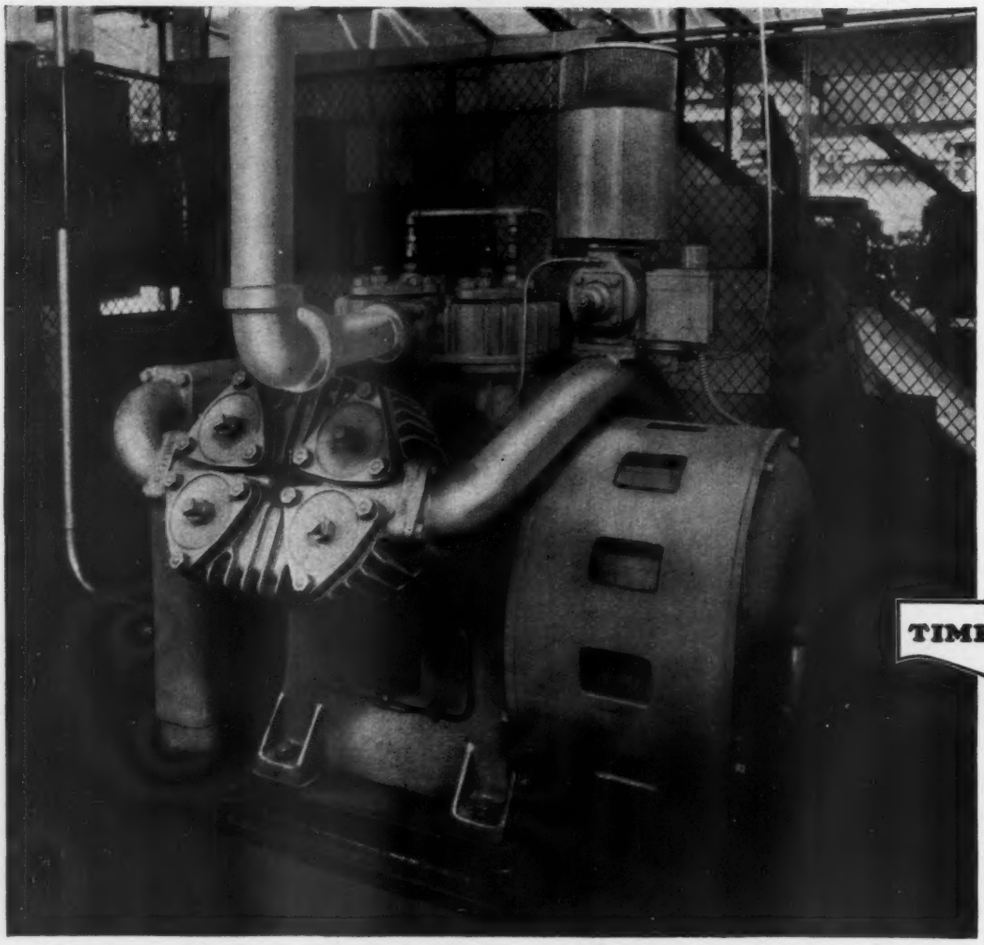

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